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AD-5843

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Tables of Dielectric Materials
Volume IV

Technical Report No. 57
Laboratory for Insulation Research
Massachusetts Institute of Technology

January, 1953

TABLES OF DIELECTRIC MATERIALS
VOLUME IV

Laboratory for Insulation Research
Massachusetts Institute of Technology
Cambridge, Massachusetts

O. N. R. Contracts N5ori-07801
N5ori-07858

January, 1953

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Tables of Dielectric Materials

Volume IV

Laboratory for Insulation Research
Massachusetts Institute of Technology
Cambridge, Massachusetts

About five years have passed since Volume III of the "Tables of Dielectric Materials" was issued. The world situation appeared to quiet down at that time, and we hoped to concentrate the whole activity of this laboratory on fundamental research in the field of dielectrics (polarization, magnetization and conduction). The outbreak of the Korean War found our country again unprepared and demonstrated with expensive clarity that we have to live on the alert for the rest of our lives. In consequence, the laboratory felt bound to retain the practical task assumed in World War II of acting as a clearing house for dielectric materials and their uses. One aspect of this activity is our long-range applied research program of tailoring dielectrics to order for specific applications. This work is concentrated at the present time on the problem of shaping the hysteresis loops of ferroelectrics and of ferromagnetic semiconductors to the requirements of the electrical engineer concerned with the development of memory systems, dielectric and magnetic amplifiers and other nonlinear devices. A second aspect is the "Tables of Dielectric Materials."

The "Tables" in their present form summarize the measurements of this laboratory on the complex permittivity (dielectric constant and loss tangent) and the complex permeability of important dielectrics made in this country. They are intended to aid government agencies, engineers and manufacturers in the proper application of dielectrics and in the development of better products. Volume IV reports on about 250 new materials; simultaneously, it has taken over and amplified the measurements given in the previous volumes as far as they still are of special interest. A number of materials now not in produc-

tion have been retained for this reason but are indicated as "discontinued." The total number of materials included amounts to over 600.

The selection of these materials was undertaken with the full co-operation of the manufacturers concerned. The laboratory measures any important new material free of charge for inclusion in the "Tables" if the manufacturer supplies all additional essential information. If some of this information is "confidential," it is locked away in our files and will be made available only after release by the manufacturer.

We are fully aware that these data should be expanded, especially towards higher temperatures and frequencies. Furthermore, additional measurements on d.c. conductivity, breakdown strength and other electric parameters would be of great value, and a presentation of the materials as in Volume II, where the dielectric characteristics of each individual dielectric have been plotted and essential information given on composition, properties, methods of handling and recommended uses. Finally, a real "dielectric analysis" of the materials should be undertaken, linking their dielectric response to composition and molecular structure. We have to ask for the indulgence of the users of these "Tables" on these scores; ultra posse nemo obligatur, or, in free translation, our budget is already stretched to the breaking point by our present obligations.

Volume IV does not contain our more extensive measurements on ferroelectrics and ferromagnetics. These data on nonlinear dielectrics will be issued in a separate Volume V as soon as they are reasonably complete.

The measurements were made by W. B. Westphal, group leader of our dielectric measurements group, who was ably supported by three staff operators: Helen M. Dunn, Patricia A. Fergus and Elizabeth McCarty. Invaluable help in the editing and correcting of the manuscript was given by Hariet B. Armstrong.

This work was sponsored under our O.N.R. contracts jointly by the Navy Department (Office of Naval Research), the Army Signal Corps and the Air Force

(Air Materiel Command); we thank all three Services for their understanding and co-operation.

A. von Hippel, Director
Laboratory for Insulation Research

Dielectric Parameters

1. ϵ'/ϵ_o, the dielectric constant or permittivity relative to vacuum, also designated in the literature as K, κ, ϵ, D.C., etc.
2. tan δ or tan δ_d, the dielectric loss tangent or dissipation factor, also designated in the literature as D.F., 1/Q, and when losses are low, as power factor or cos θ.
3. μ'/μ_o, the magnetic permeability relative to vacuum, also given in the literature as μ' or μ_o.
4. tan δ_m, the magnetic loss tangent.
5. ρ, the a.c. volume resistivity in ohm cm. This parameter is used in these tables only for very high-loss materials.

Transformation to other parameters. The dielectric loss factor relative to vacuum, ϵ''/ϵ_o, is the product of the dielectric loss tangent and ϵ'/ϵ_o. A.c. volume conductivity, σ, is given by

$$\sigma = \frac{1}{\rho} = \frac{f(\epsilon'/\epsilon_o)\tan\delta}{1.8\text{x}10^{12}} \quad [\text{mho cm.}]\,(f \text{ in c/s}) \quad .$$

A chart is given (page x) for approximate calculations of σ or ρ from the data given in the tables.

The magnetic loss factor relative to vacuum, μ''/μ_o, is the product of the magnetic loss tangent and μ'/μ_o (in analogy to the dielectric loss factor). In the literature, the loss factor is sometimes given as $\frac{1}{\mu_o' Q}$ or in our notation, tan $\delta_m/(\mu'/\mu_o)$.

The attenuation constant, α, for propagation in free space is

$$\frac{2\pi}{\lambda_o}\left[\frac{\mu'\epsilon'}{\mu_o\epsilon_o}\;\frac{1 - \tan\delta_d \cdot \tan\delta_m}{2}\left(\left[1 + \tan^2(\delta_d + \delta_m)\right]^{1/2} - 1\right)\right]^{1/2} ,$$

which for nonmagnetic dielectrics reduces to

$$\frac{2\pi}{\lambda_o}\left(\frac{\epsilon'}{\epsilon_o}\right)^{1/2}\left[\frac{(1 + \tan^2\delta_d)^{1/2} - 1}{2}\right]^{1/2} .$$

Charts for finding α in terms of ϵ'/ϵ_o and tan δ_d are included in this report (pages xi-xiii). They apply also to magnetic dielectrics when the product $(\mu'/\mu)(\epsilon'/\epsilon_o)$ is substituted for ϵ'/ϵ_o and an equivalent combined loss tangent tan δ_e is used instead of tan δ_d. A graph is given (page xiv) showing tan δ_e for values of tan δ_d and tan δ_m in the range 0.1 to 10. For smaller values, tan δ_e = tan δ_d + tan δ_m.

The phase constant β for propagation in free space is

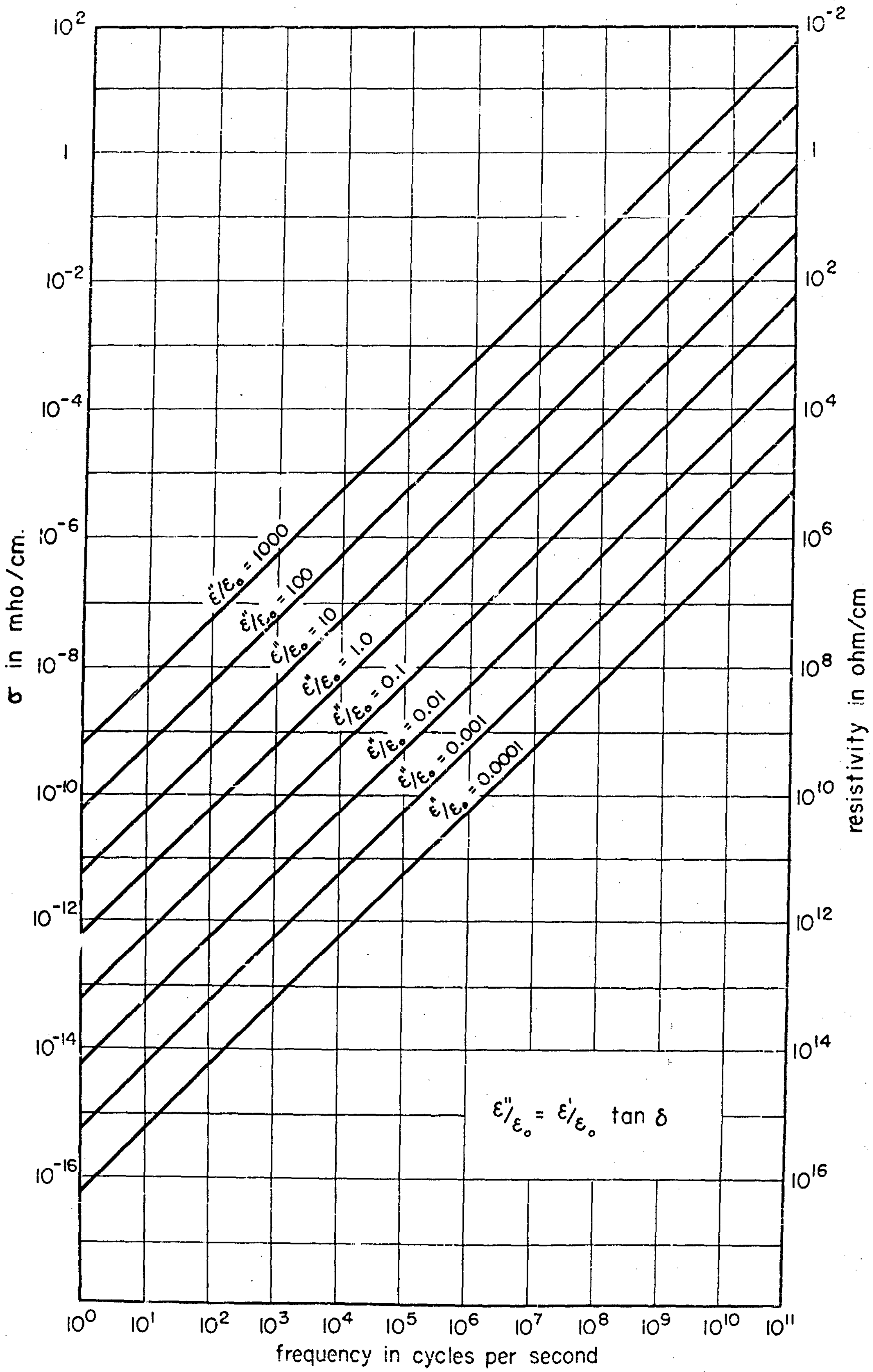
$$\frac{2\pi}{\lambda_o}\left[\frac{\mu'\epsilon'}{\mu_o\epsilon_o}\,\frac{1 - \tan\delta_d \cdot \tan\delta_m}{2}\left(\left[1 + \tan^2(\delta_d + \delta_m)\right]^{1/2} + 1\right)\right]^{1/2} ,$$

which reduces for nonmagnetic materials to

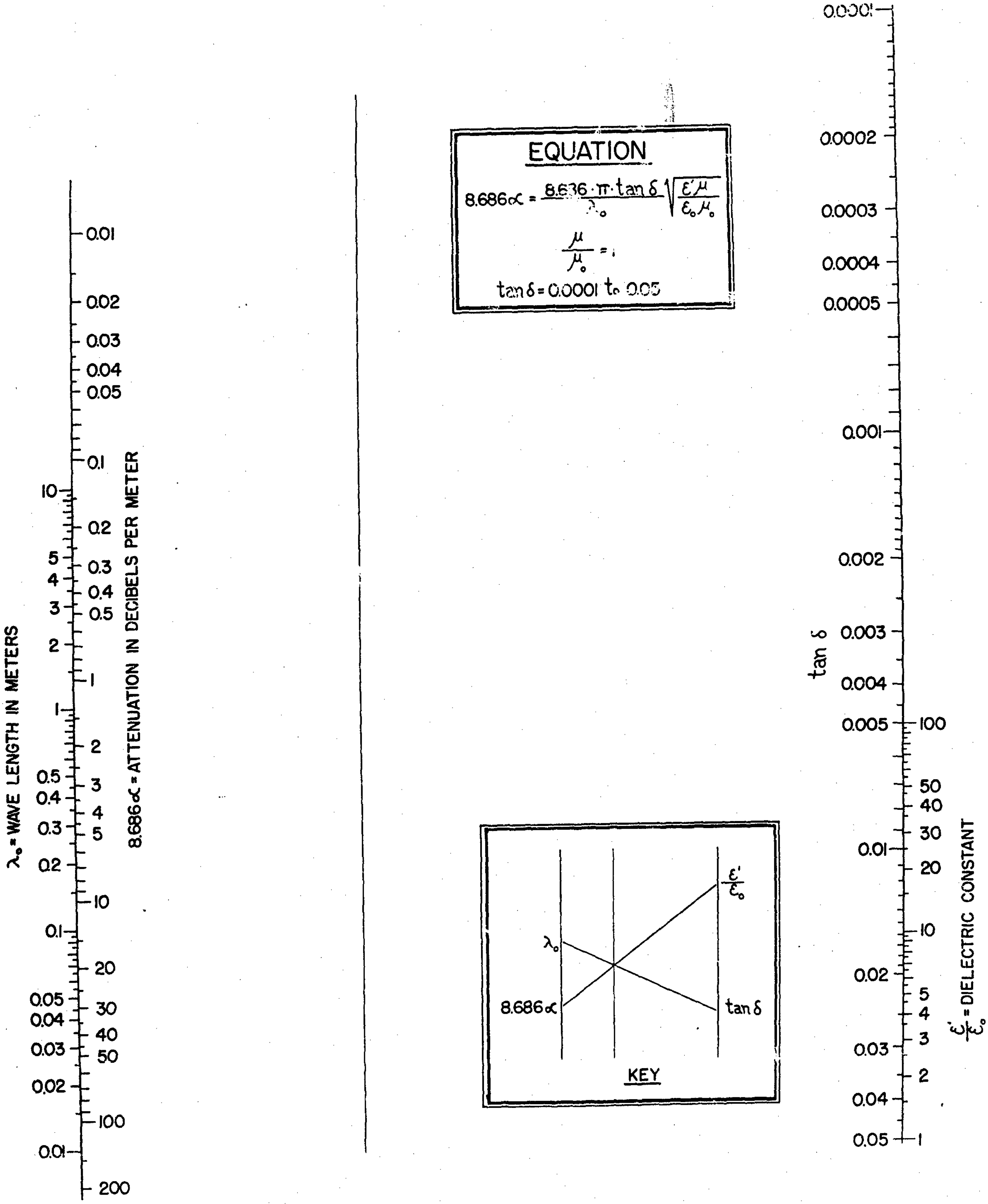
$$\frac{2\pi}{\lambda_o}\left(\frac{\epsilon'}{\epsilon_o}\right)^{1/2}\left[\frac{(1 + \tan^2\delta_d)^{1/2} + 1}{2}\right]^{1/2} .$$

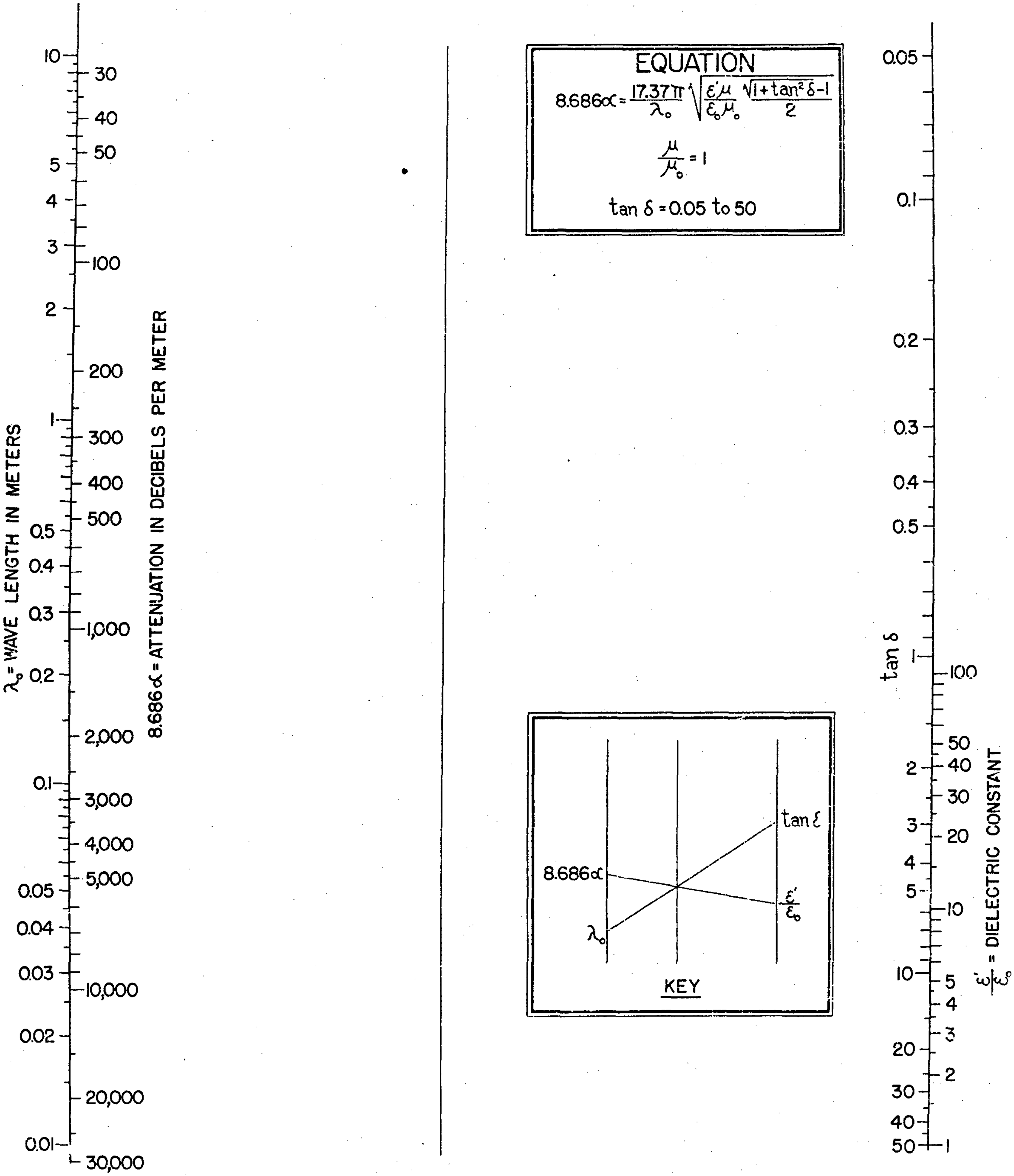
The intrinsic impedance Z of the material is

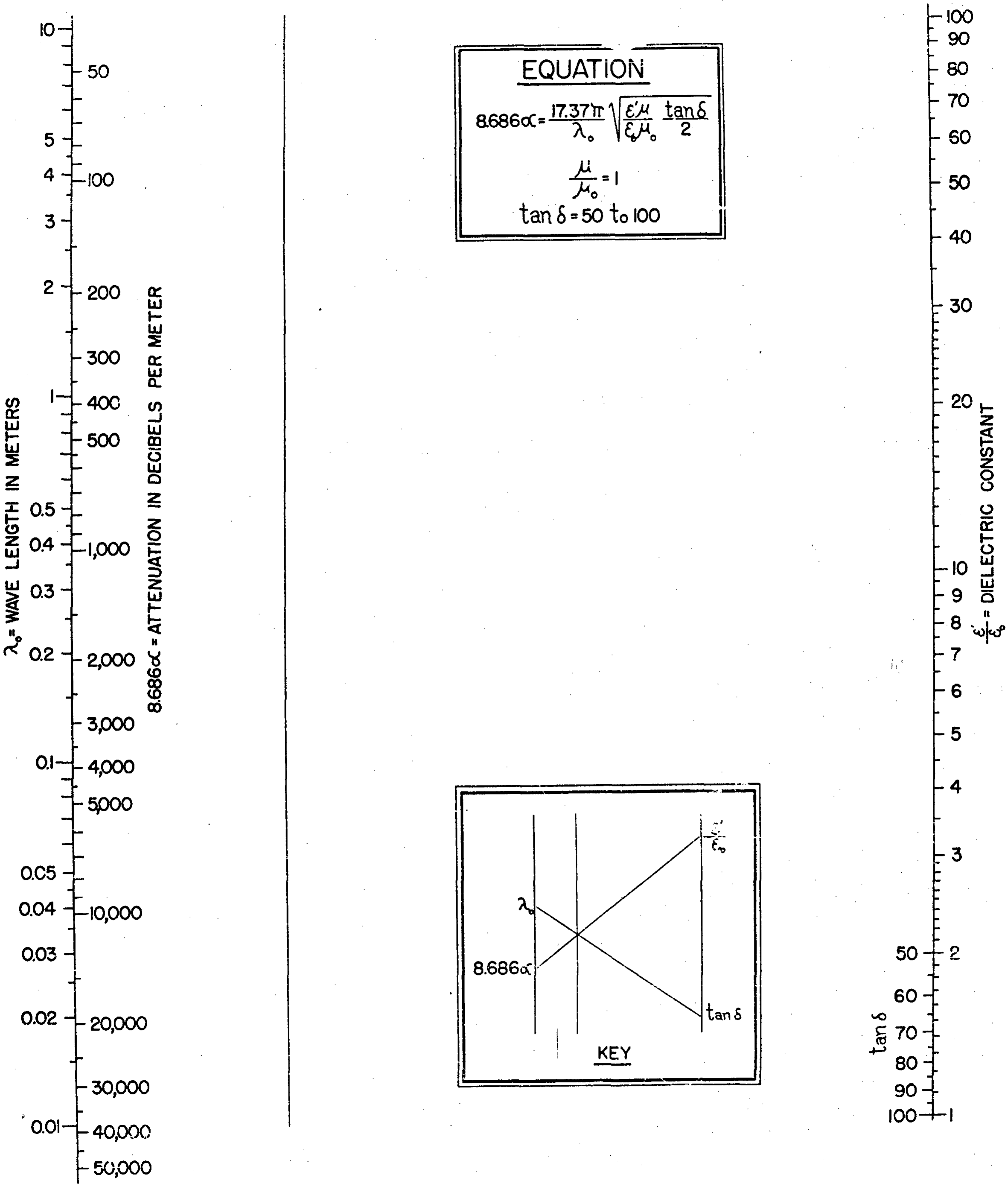
$$377\left(\frac{\mu^*\epsilon_o}{\mu_o\epsilon^*}\right)^{1/2} .$$



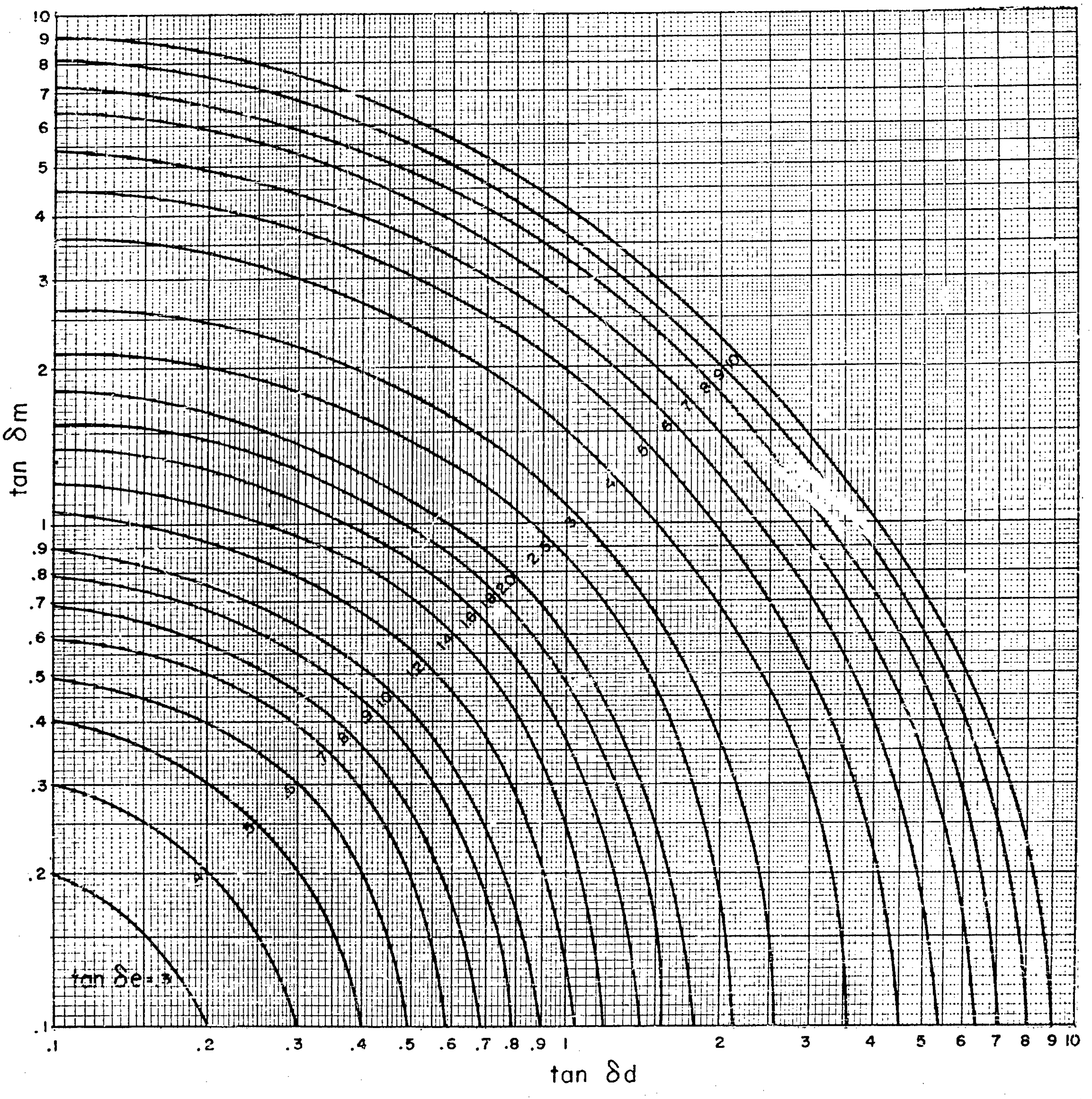
Conductivity-resistivity as function of ϵ''/ϵ_o and frequency.


EQUATION
8.686α = (8.686 · π · tan δ / λ₀) √(ε′μ / ε₀μ₀)
μ/μ₀ = 1
tan δ = 0.0001 to 0.05
λ₀ = WAVE LENGTH IN METERS
8.686α = ATTENUATION IN DECIBELS PER METER
tan δ
ε′/ε₀ = DIELECTRIC CONSTANT
KEY
λ₀
8.686α
ε′/ε₀
tan δ
10
5
4
3
2
1
0.5
0.4
0.3
0.2
0.1
0.05
0.04
0.03
0.02
0.01
0.01
0.02
0.03
0.04
0.05
0.1
0.2
0.3
0.4
0.5
1
2
3
4
5
10
20
30
40
50
100
200
0.0001
0.0002
0.0003
0.0004
0.0005
0.001
0.002
0.003
0.004
0.005
0.01
0.02
0.03
0.04
0.05
100
50
40
30
20
10
5
4
3
2
1


EQUATION
$8.686\alpha = \frac{17.37\pi}{\lambda_0}\sqrt{\frac{\varepsilon'\mu}{\varepsilon_0\mu_0}\,\frac{\sqrt{1+\tan^2\delta}-1}{2}}$
$\frac{\mu}{\mu_0} = 1$
$\tan\delta = 0.05$ to 50
λ_0 = WAVE LENGTH IN METERS
8.686α = ATTENUATION IN DECIBELS PER METER
$\tan\delta$
$\frac{\varepsilon'}{\varepsilon_0}$ = DIELECTRIC CONSTANT
KEY
8.686α
λ_0
$\tan\delta$
$\frac{\varepsilon'}{\varepsilon_0}$



EQUATION
$8.686\alpha = \frac{17.37\pi}{\lambda_0}\sqrt{\frac{\varepsilon'\mu}{\varepsilon_0\mu_0}\,\frac{\tan\delta}{2}}$
$\frac{\mu}{\mu_0} = 1$
$\tan\delta = 50$ to 100
λ_0 = WAVE LENGTH IN METERS
8.686α = ATTENUATION IN DECIBELS PER METER
$\frac{\varepsilon'}{\varepsilon_0}$ = DIELECTRIC CONSTANT
$\tan\delta$
KEY
λ_0
8.686α
$\frac{\varepsilon'}{\varepsilon_0}$
$\tan\delta$



Equivalent loss tangent of magnetic materials.

Measurements and Accuracy

The measurements have been made, in general, on only one batch of the material and refer, unless otherwise specified, to samples dried over phosphorous pentoxide. Due to the wide variety of materials and improvements in techniques, no figures of general validity can be given concerning the accuracy of these measurements. For ϵ'/ϵ_o, the nominal accuracy is $\pm 2\%$; the accuracy trends are toward $\pm 1\%$ for rigid, low-loss materials ($\tan \delta < 0.005$) and $\pm 5\%$ for high-loss materials ($\tan \delta > 1$). For $\tan \delta_d$, the nominal accuracy is $\pm 5\%$; for high-loss materials, the error may be $\pm 10\%$. For very low-loss materials ($\tan \delta < 0.002$), the accuracy is ± 0.0001 when the losses are given as multiples of 0.0001. When the loss is expressed in multiples of 0.00001, the error may be ± 0.00003. For μ'/μ_o, the nominal accuracy is $\pm 5\%$, for $\tan \delta_m$, $\pm 10\%$.

Field strengths. The linear dielectrics, those normally not field-strength sensitive, were measured at field strengths of approximately 50 volts per cm. in the frequency range 10^2 to 10^8 c/s and at lower field strengths at higher frequencies. At high temperatures (near 500°C) many of these materials show field-strength sensitivity, particularly at low frequencies. The effects may be wholly or partly due to space charge polarization.

The ferroelectric and ferromagnetic materials, unless otherwise noted, were measured at field strengths in their linear region. The values thus measured are the initial permittivity and permeability. Typical field strengths are 40 volts/cm. for titanate ceramics, 0.01 volts/cm. for KDP crystals, 0.01 oersteds for the ferrites.

I. SOLIDS

Values for tan δ are multiplied by 10^4; frequency given in c/s.

A. Inorganic

1. Crystals

	$T^\circ C$		1×10^2	1×10^3	1×10^4	1×10^5	1×10^6	1×10^7	1×10^8	3×10^8	3×10^9	1×10^{10}	2.5×10^{10}
Ice[a]	-12	ϵ'/ϵ_o	----	----	----	4.8	4.15	3.7	----	----	3.20	3.17	
		tan δ	----	----	----	8000	1200	180	----	----	9	7	
Snow[b]	-20	ϵ'/ϵ_o	----	3.33	1.82	1.24	1.20	1.20	----	1.20	1.20	1.26*	
		tan δ	----	4920	3420	1400	215	40	----	12	2.9	4.2*	
Snow[c]	-6	ϵ'/ϵ_o	----	----	----	1.9	1.55	----	----	----	1.5		
		tan δ	----	----	----	15300	2900	----	----	----	9		
Aluminum oxide, sapphire[d]	25	ϵ'/ϵ_o	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	----	----	8.6
(field ⊥ optical axis)		tan δ	< 10	< 2	< 10	< 10	< 10	< 10	< 10	< 1	----	----	14
(field ∥ optical axis)		ϵ'/ϵ_o	10.55	10.55	10.55	10.55	10.55	10.55	10.55	10.55			
		tan δ	< 10	< 2	< 10	< 10	< 10	< 10	< 10	< 1			
Ammonium dihydrogen phosphate (field ⊥ optical axis)[e]	25	ϵ'/ϵ_o	56.4	56.0	55.9	55.9	55.9	55.9	55.9	55.9			
		tan δ	400	46	4.6	< 5	< 5	< 5	< 5	< 10			
(field ∥ optical axis)		ϵ'/ϵ_o	16.4	16.0	15.4	14.7	14.3	14.3	----	14.3	----	13.7	
		tan δ	2400	240	70	70	60	10	----	5	----	50	
Lithium fluoride[f]	25	ϵ'/ϵ_o	9.00	9.00	9.00	9.00	9.00	9.00	----	9.00	----	9.00	
		tan δ	15	< 3	< 2	< 2	< 2	< 2	----	.7	----	1.8	
	80	ϵ'/ϵ_o	9.11	9.11	9.11	9.11	9.11	9.11	----	----	----	9.11	
		tan δ	120	20	11	4	< 2	< 2	----	----	----	3.3	
Magnesium oxide[g]	25	ϵ'/ϵ_o	9.65	9.65	9.65	9.65	9.65	9.65	9.65				
		tan δ	< 3	< 3	< 3	< 3	< 3	< 3	< 3				
Potassium bromide[f]	25	ϵ'/ϵ_o	4.90	4.90	4.90	4.90	4.90	4.90	----	4.90	----	4.90	
		tan δ	7	7	8	4.5	< 2	< 2	----	< 1	----	2.3	
	87	ϵ'/ϵ_o	4.97	4.97	4.97	4.97	4.97	4.97	----	4.97	----	4.97	
		tan δ	16	7	11	9	5	3	----	2.4	----	3.5	
Potassium dihydrogen phosphate (field ⊥ optical axis)[e]	25	ϵ'/ϵ_o	44.5	44.3	44.3	44.3	44.3	4.43	4.43				
		tan δ	98	15	< 5	< 5	< 5	< 5	< 5				
(field ∥ optical axis)		ϵ'/ϵ_o	21.4	20.7	20.5	20.3	20.2	20.2	20.2				
		tan δ	170	24	< 20	< 5	< 5	< 5	< 5				
Selenium, multi-crystalline[h]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	11.0	10.4	----	7.5
		tan δ	----	----	----	----	----	----	----	2500	1540	----	1100

a. From conductivity water. b. Freshly fallen snow. c. Hard-packed snow followed by light rain. d. Linde Air. e. Brush.
f. Fresh crystals (Harshaw). g. Norton. h. Lab. Ins. Res.
* -6°C.

I. Solids, A. Inorganic,

1. Crystals (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

	$T^\circ C$		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Sodium chloride[a]	25	ϵ'/ϵ_o	5.90	5.90	5.90	5.90	5.90	5.90					5.90
		tan δ	< 1	< 1	< 1	< 2	< 2	< 2					< 5
	85	ϵ'/ϵ_o	6.35	6.11	6.00	5.98	5.98	5.98					5.97
		tan δ	170	240	70	6	< 2	< 2					< 3.9
Sulfur[b] (100)	25	ϵ'/ϵ_o	3.75	3.75									
		tan δ	< 5	< 5									
(010)	25	ϵ'/ϵ_o	3.95	3.95									
		tan δ	< 5	< 5									
(001)	25	ϵ'/ϵ_o	4.45	4.45									
		tan δ	< 5	< 5									
Sulfur, sublimed[c]	25	ϵ'/ϵ_o	3.69	3.69	3.69	3.69	3.69	3.69	----	----	3.62	3.58	
		tan δ	3	2	< 2	< 2	< 2	< 2	----	----	.4	1.5	
Thallium bromide[d]	25	ϵ'/ϵ_o	31.1	30.3	30.3	30.3	30.3	30.3					
		tan δ	1300	128	13.3	2	1	.4					
Thallium iodide[d]	25	ϵ'/ϵ_o	22.3	21.8	21.8	21.8	21.8	21.8					
		tan δ	950	120	12	1.2	.5	.5					
	193	ϵ'/ϵ_o	----	----	----	----	----	37.3					
		tan δ	----	----	----	----	----	820					
Thallium bromide - chloride[d,e]	25	ϵ'/ϵ_o	32.9	32.0	32.0	31.8							
		tan δ	4500	441	46	5.9							
Thallium bromide - iodide[d, f]	25	ϵ'/ϵ_o	32.9	32.8	32.5	32.5	32.5	32.5					
		tan δ	29800	2800	277	37	4	.4					
Titanium dioxide, rutile[g] (field ⊥ optical axis)	25	ϵ'/ϵ_o	87.3	86.7	86.4	86	85.8	85.8					
		tan δ	110	32	9	4	2	2					
(field ‖ optical axis)	25	ϵ'/ϵ_o	----	----	200	170	170	160					
		tan δ	----	----	3500	600	80	16					

a. Fresh crystals (Harshaw). b. Measured with field ⊥ to cuts indicated. Grown at Lab. Ins. Res. c. U.S.P. d. Grown at Eng. Res. and Dev. Lab., Fort Belvoir, Va. e. KRS-6, 60% ThBr, 40% ThCl. f. KRS-5, 42% ThBr, 58% ThI. g. Linde Air.

Values for tan δ are multipled by 10^4; frequency given in c/s.

2. Ceramics

a. Steatite Bodies

	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
AlSiMag A-35[a]	23	ϵ'/ϵ_o	6.10	5.96	5.89	5.86	5.84	5.80	5.75	----	5.60	-----	5.36
		tan δ	150	100	70	50	38	35	37	----	41	----	58
	85	ϵ'/ϵ_o	6.84	6.37	6.11	5.96	5.86	5.80	5.75	----	5.50		
		tan δ	890	370	175	103	77	50	50	----	47		
AlSiMag A-196[a]	25	ϵ'/ϵ_o	5.90	5.88	5.84	5.80	5.70	5.65	5.60	----	5.42	5.24	5.18
		tan δ	30	59	79.5	55	30.5	19	16	----	18	26	38
	81	ϵ'/ϵ_o	5.90	5.88	5.84	5.80	5.70	5.65	5.60	----	5.42	-	
		tan δ	58	40	46.5	70.5	66	40.5	24	----	18	-	
AlSiMag 211[a]	25	ϵ'/ϵ_o	6.00	5.98	5.98	5.97	5.97	5.96	5.96	----	----	5.90	
		tan δ	92	34	12	6	5	4	4	----	----	14	
AlSiMag 228[a]	25	ϵ'/ϵ_o	6.40	6.40	6.40	6.40	6.36	6.30	6.20	----	5.97	5.93	5.83
		tan δ	15.6	20	20	15.6	12.4	11.2	10	----	13	19.5	42
	81	ϵ'/ϵ_o	6.52	6.46	6.40	6.40	6.36	6.30	----	----	5.95		
		tan δ	35.6	22	18	21.5	18.4	11.8	----	----	11		
AlSiMag 243[a]	22	ϵ'/ϵ_o	6.30	6.30	6.28	6.25	6.22	6.17	6.10	----	5.78	5.76	5.75
		tan δ	12.5	4.5	4.0	< 9	3.7	3.5	3	----	6	8.5	12
	85	ϵ'/ϵ_o	6.37	6.37	6.37	6.36	6.32	6.28	----	----	5.88		
		tan δ	21	13.7	8.0	< 9	3.7	3.5	----	----	6		
AlSiMag 393[b]	24	ϵ'/ϵ_o	4.95	4.95	4.95	4.95	4.95	4.95	4.95	----	----	4.95	4.91
		tan δ	38	23	16	12	10	10	10	----	----	9.7	14
Ceramic F-66[c]	25	ϵ'/ϵ_o	6.22	6.22	6.22	6.22	6.22	6.22	6.22	----	6.22	----	6.2
		tan δ	14.5	9	5	2	1	1.5	3	----	5.5	----	11
Steatite Type 302[d]	25	ϵ'/ϵ_o	5.80	5.80	5.80	5.80	5.80	5.80	5.80	----	5.8	5.8	
		tan δ	32	20	16	13	12	12	12	----	19	36	
Steatite Type 400[d]	25	ϵ'/ϵ_o	5.54	5.54	5.54	5.54	5.54	5.54	5.54	----	5.5	5.5	
		tan δ	160	100	72	60	50	45	39	----	39	53	
Steatite Type 410[d]	25	5.77	5.77	5.77	5.77	5.77	5.77	5.77	5.77	----	5.7	5.7	
		tan δ	55	30	16	9	7	6	6	----	8.9	22	
Steatite Type 452[d]	25	ϵ'/ϵ_o	8.15	8.15	8.15	8.15	8.15	8.15	8.15	----	8.15	8.15	
		tan δ	65	28	17	12	10	10	10	----	20	31	

a. Magnesium silicate (Am. Lava). b. 93% Al_2O_3. 6% SiO_2. 1% MgO (Am. Lava). c. 60% talc, 15% kaolin, 17.5% $BaCO_3$, 7.5% $MgCO_3$ (Bell). d. Centralab.

I. Solids, A. Inorganic (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

2. Ceramics (cont)

a. Steatite Bodies(cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Steatite Body 7292[a]	25	ϵ'/ϵ_o	6.55	6.55	6.54	6.53	6.53	6.53	6.53	6.53	6.52	6.51	
		tan δ	14	7	4.8	3.9	4.9	5.2	6.2	6.8	9	10.9	
Crolite #29[b]	24	ϵ'/ϵ_o	6.04	6.04	6.04	6.04	6.04	6.04	----	----	5.90	5.71	
		tan δ	25	19	15	13	11	10	----	----	24	30	
b. Titania and Titanate Bodies													
Ceramic NPOT96[c]	25	ϵ'/ϵ_o	29.5	29.5	29.5	29.5	29.5	29.5	29.5	----	----	28.9	
		tan δ	12	4.9	3.3	2.5	1.6	1.7	2	----	----	20	
Ceramic N750T96[c]	25	ϵ'/ϵ_o	83.4	83.4	83.4	83.4	83.4	83.4	83.4	----	----	83.4	
		tan δ	5.7	4.5	3.5	2.5	2.2	2.3	4.6	----	----	14.6	
Ceramic N1400T110[c]	25	ϵ'/ϵ_o	131	130.8	130.7	130.5	130.2	130.2	130.0				
		tan δ	6.7	5.5	3.3	1.4	3.0	5.5	7.0				
Body T106[c]	25*	ϵ'/ϵ_o	1518	1508	1480								
		tan δ	31	87	99								
	25**	ϵ'/ϵ_c	1308	1280	1260	1245	1232	1220	1210				
		tan δ	98	120	140	100	85	150	420				
TI Pure R-200[d]	26	ϵ'/ϵ_o	100	100	100	100	100	100	100	----	----	90	
		tan δ	23	15	6.2	4	3	2.5	2.5	----	----	20	
	78	ϵ'/ϵ_o	97.5	97	97	97	97	97					
		tan δ	130	60	33	13	4.5	2.3					
Tam Ticon T-J, T-L and T-M[e]	24	ϵ'/ϵ_o	96	96	96	96	96	96	----	----	96	----	91
		tan δ	8	4.5	2	1	2	3	----	----	3.4	----	33
	78	ϵ'/ϵ_o	90	89	88.5	88	87.5	87					
		tan δ	55	16	4	4	4	4					
Tam Ticon MC[f]	25	ϵ'/ϵ_o	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.8	13.8	13.7
		tan δ	15	11	9	7	4	4	5	9	17	28	65

a. Gen. Ceramics and Steatite. b. Al_2O_3, SiO_2, MgO, CaO, BaO (Crowley). c. Amer. Lava. d. Rutile (Dupont, fired at Lab. Ins. Res.). e. Rutile (Titanium Alloy, fired at Lab. Ins. Res.). f. Magnesium titanate (Titanium Alloy, fired at Lab. Ins. Res.).

* - 3/4" Disk. ** 0.2" disk cut from 3/4" disk.

I. Solids, A. Inorganic (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

2. Ceramics (cont.)

b. Titania and titanate bodies (cont.)

Titania and titanate bodies (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Titania Ceramic[a]	25	ε'/ε₀	----	----	----	----	33						
		tan δ	----	----	----	----	5.2						
Titania Ceramic[b]	25	ε'/ε₀	----	----	----	----	----	60.5	----	60			
		tan δ	----	----	----	----	----	8.3	----	11			
Tam Ticon C[c]	25	ε'/ε₀	167.8	167.7	167.7	167.7	167.7	167.7	----	166.8	165	165	
		tan δ	13.6	4.4	2.5	2	2	2	----	5	23	85	
	82	ε'/ε₀	157	156	156	156	156	156					
		tan δ	400	49	11	6	6	6					
Tam Ticon S[d]	25	ε'/ε₀	234	233	232	232	232	232	232	----	----	230	
		tan δ	21	11	8	5	2	1	1	----	----	28	
Tam Ticon B[e]	25	ε'/ε₀	1240	1200	1170	1153	1143	1140	----	1100	600	150	100
		tan δ	360	130	150	120	105	75	----	500	3000	5000	6000
Tam Ticon BS[f]	25	ε'/ε₀	8700	8500	8200	8100	8000	8000	8000	7000	2000	200	
(discontinued)		tan δ	230	200	230	90	48	98	400	900	5000	4000	
Mix 71 $BaTiO_3$[g]	25	ε'/ε₀	1740	1720	1680	1650							
		tan δ	63	107	170	150							
Mix 72 $BaTiO_3$ 90%[g]	25	ε'/ε₀	1310	1307	1300	1280	1275						
$SrTiO_3$ 10%		tan δ	31	43	70	77	46						
Mix 73 $BaTiO_3$ 80%[g]	25	ε'/ε₀	2163	2160	2120	2020	1960						
$SrTiO_3$ 20%		tan δ	94	155	280	200	75						
Mix 74 $BaTiO_3$ 70.9%[g]	25	ε'/ε₀	2990	2970	2910	2840	2820						
$SrTiO_3$ 29.1%		tan δ	47	61	88	67	40						
Mix 75 $BaTiO_3$ 60%[g]	25	ε'/ε₀	1125	1122	1120	1110	1090						
$SrTiO_3$ 40%		tan δ	110	72	45	30	19						

a. 84.3% TiO_2, 11.1% $MgCO_3$ =4.6% $MgOSiO_2$ (Lab. Ins. Res.). b. 84.6% TiO_2, 15.4% kaolin (Lab. Ins. Res.). c. Calcium titanate (Titanium Alloy; fired at Lab. Ins. Res.). d. Strontium titanate (Titanium Alloy; fired at Lab. Ins.Res.). e. Barium titanate (Titanium Alloy; fired at Lab. Ins. Res.). f. 79% barium, 21% strontium titanate (Titanium Alloy; fired at Lab. Ins. Res.).
g. Thin sheet (Glenco).

I. Solids, A. Inorganic (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

2. Ceramics (cont.)

b. Titania and titanate bodies (cont.)

Material	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Mix 76 $BaTiO_3$ 50%[a]	25	ϵ'/ϵ_o	740	738	735	732	730	----	----	----	----	----
$SrTiO_3$ 50%		tan δ	10.7	6	7	21	28	----	----	----	----	----
Mix 77 $BaTiO_3$ 68.1%[a]	25	ϵ'/ϵ_o	892	890	890	890	890	----	----	----	----	----
$SrTiO_3$ 28.1%		tan δ	16	10	12	25	8	----	----	----	----	----
$MgZrO_3$ 2.8%												
c. Porcelains												
Zirconium porcelain Zi-4[b]	25	$\epsilon'\epsilon_o$	6.44	6.40	6.35	6.32	6.32	6.30	6.30	6.30	6.23	6.18
		tan δ	59	40	31	27	23	21	25	27	45	57
Porcelain, wet process[c]	25	ϵ'/ϵ_o	6.47	6.24	6.08	5.98	5.87	5.82	5.80	5.75	----	5.51
		tan δ	280	180	130	105	90	115	135	140	----	155
Porcelain, dry process[c]	25	ϵ'/ϵ_o	5.50	5.36	5.23	5.14	5.08	5.04	5.04	5.02	----	4.74
		tan δ	220	140	105	85	75	70	78	98	----	156
Coors AI-200[d]	25	ϵ'/ϵ_o	8.83	8.83	8.82	8.80	8.80	8.80	8.80	----	8.79	8.79
		tan δ	14	5.7	4.8	3.8	3.3	3.2	3.0	----	10	18
Porcelain #4462[e]	25	ϵ'/ϵ_o	8.99	8.95	8.95	8.95	8.95	8.95	8.95	8.93*	8.90	8.80
		tan δ	22	9.1	6.0	3.0	2.0	2.0	4.0	9*	11	14
Coors AB-2[d]	25	ϵ'/ϵ_o	8.22	8.18	8.17	8.17	8.16	8.16	8.16	----	8.14	8.08
		tan δ	20	13.4	11.4	10.5	9.0	7.5	9.0	----	16	27
AlSiMag 491[f]	25	ϵ'/ϵ_o	----	----	----	----	8.74	----	----	----	8.60	8.50
		tan δ	----	----	----	----	22	----	----	----	17	23
d. Miscellaneous Ceramics												
Beryllium oxide[g]	25	ϵ'/ϵ_o	4.61	4.47	4.41	4.34	4.28	4.24	4.23	----	----	4.20
		tan δ	170	84	74	72	38	19	12.5	----	----	5
Porous Ceramic AF-497[h]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	1.472
		tan δ	----	----	----	----	----	----	----	----	----	17

a. Thin sheet (Glenco). b. Coors. c. Knox. d. Aluminum oxide (Coors). e. Aluminum oxide (Frenchtown Porcelain). f. Aluminum oxide (Amer. Lava). g. Norton. h. 63% diatomaceous-earth, 32% anthracite coal, 5.5% whiting (Stupakoff).
*Frequency = $1x10^9$.

I. Solids, A. Inorganic, 2. Ceramics (cont.)

e. Ferrites

Frequency given in c/s; temperature = 25°C.

Freq.	Crowloy 20[a] ϵ'/ϵ_o	$\tan\delta_d$	μ'/μ_o	$\tan\delta_m$	Crowloy 70[a] ϵ'/ϵ_o	$\tan\delta_d$	μ'/μ_o	$\tan\delta_m$	Crowloy BX113[a]* ϵ'/ϵ_o	$\tan\delta_d$	μ'/μ_o	$\tan\delta_m$	Crowloy BX114[a] ϵ'/ϵ_o	$\tan\delta_d$	μ'/μ_o	$\tan\delta_m$
10^2	35400	2.41	----	----	440000	26.7	400	----	19.4	.59	----	----	29	.58	21	
$4x10^2$	9900	3.94	----	----	-----	----	----	----	----	----	----	----	19.2			
10^3	5430	2.65	120	----	350000	3.35	400	----	14.7	.20	14.5	----	19.2	.30	17.5	
10^4	1590	1.47	120	----	250000	.78	400	----	13.0	.066	14.5	----	14.9	.15	15.6	
10^5	480	1.6	120	----	123000	.64	400	----	12.8	.024	14.5	----	12.9	.06	14.5	
10^6	-----	----	----	----	-----	----	440	.28	12.6	.010	14	----	12.6	.024		
$3x10^6$	-----	----	108	.08	-----	----	147	1.53	----	----	13	< .1	----	----	16	< .1
10^7	18	1.1	84	.48	16400	1.4	92	.24	12.5	.005	12,47	< .1, .02	12.4	.007	18.5	< .1
$2x10^7$	-----	----	----	----	-----	----	----	----	----	----	12	< .2				
$3x10^7$	-----	----	47	.92	-----	----	----	----	----	----	12.8,46	.05, .03	----	----	20.7	< .1
$6.5x10^7$	-----	----	35	1.16	-----	----	41	1.92	----	----	51	.25	----	----	23	< .1
$8x10^7$	-----	----	24.6	1.58	-----	----	29	2.36	----	----	49.4	.46	----	----	24	< .1
10^8	-----	----	17.9	2.15	-----	----	18	3.35	12.5	.0026	37	.74	12.4	.0037	26	< .1
$1.2x10^8$	-----	----	15.9	1.98	-----	----	21	2.58	----	----	34	.9	----	----	30	.13
$1.4x10^8$	-----	----	24.6	1.43	-----	----	----	----	----	----	28.5	1.15	----	----	31	.32
$3x10^8$	-----	----	----	----	-----	----	----	----	----	----	17.9	1.5	----	----	17.6	1.61
$9x10^8$	12	.07	----	----	-----	----	----	----	----	----	5.34	3.4	----	----	3.25	4.46
10^9	12	.07	.98	5.8												
$3x10^9$	12	.04	.28	7.2	42	----	.19	10.6	12	<.012	1.74	1.9	12	<.01	1.34	2.48

a. H. L. Crowley.

*Two samples were measured; they differed as shown by the two sets of values at 10^7 and $3x10^7$. Lower μ'/μ_o values were obtained on sample cut from 2" disk, higher values on 3/4" disk. ϵ^*/ϵ_o values did not differ.

I. Solids, A. Inorganic, 2. Ceramics (cont.)

e. Ferrites (cont.)

Frequency given in c/s; temperature = 25°C.

	Ferramic A[a,b]				Ferramic B[a]				Ferramic C[a]				Ferramic D[a]			
Freq.	ϵ'/ϵ_o	$\tan\delta_d$	μ'/μ_o	$\tan\delta_m$	ϵ'/ϵ_o	$\tan\delta_d$	μ'/μ_o	$\tan\delta_m$	ϵ'/ϵ_o	$\tan\delta_d$	μ'/μ_o	$\tan\delta_m$	ϵ'/ϵ_o	$\tan\delta_d$	μ'/μ_o	$\tan\delta_m$
10^3	9.82	.112	19.6	----	20800	4.5	----	----	110000	2.4	240	----	35000	84	380	
10^4	9.30	.026	19.6	----	19700	4.8	94	----	32000	1.44	240	----	35000	8.1	380	
10^5	9.13	.0076	19.5	----	15500	.78	----	----	22000	1						
10^6	8.99	.0032	19.4	----	8600	.65	----	----	13500	1.32	242	.015	17600	.77	510	<.05
$2x10^6$	----	----	20.0	----	----	----	108	.027	-----	----	259	----	-----	----	550	.18
$3x10^6$	----	----	22	----	----	----	----	----	-----	----	267	.068	11000	.80	565	.47
$4x10^6$	----	----	----	----	----	----	----	----	-----	----	----	----	-----	----	411	.55
$7x10^6$	----	----	23	----	----	----	----	----	-----	----	----	----	-----	----	112	2.76
10^7	8.87	.0016	24.6	.08	1060	2.9	107	.36	2850	2.0	195	.85	6000	.90	52	4.0
$2x10^7$	----	----	25.4	.177	----	----	----	----	-----	----	78	1.6	-----	----	17.7	5.8
$3x10^7$	----	----	----	----	----	----	62	.67	-----	----	33.5	2.7	-----	----	12.9	6.2
$5x10^7$	8.5	<.1	12.5	1.00												
10^8	----	----	7.2	1.29	----	----	----	----	-----	----	----	----	485	2.9		
$3x10^8$	----	----	2.8	1.6	51	1.56	14.4	1.12	64	.70	16.8	.61	106	3.1	1.09	18.4
$5x10^8$	----	----	2.0	1.2												
10^9	8.5	<.1	3.0	.67												
$2x10^9$	----	----	1.0	2.0												
$3x10^9$	----	----	.6	2.0	20	.68	.29	10	24.6	1.14	.18	22	35	3.3	.15	20
10^{10}	8.5	<.1	1.0	----	15	.52	.42	.37	18.7	.58	.51	1.26	30	1.35	1.9	1.0
	Ferramic G[a]				Ferramic H[a]				Ferramic I[a]				Ferramic J[a]			
10^3	----	----	450	----	670000	7.2	720	----	12000	2.9	890	----	-----	----	256	
10^4	23.5	.60	400	----	152500	4.5	720	----	7800	.81	890	----	17.5	1.95	256	
10^5	15.5	.216	360	----	22400	4.2	720	----	930	3.1	890	<.1	13.8	.37	256	
10^6	13.6	.069	340	.05	1600	8.2	690	.18	90	4.7	1050	.29	12.6	.062	256	.015
10^7	13.0	.026	245	.66	-----	----	300	1.33	26	2.1	215	1.6	12.4	.015	196	.66
$3x10^8$	----	----	----	----	-----	----	----	----	13.6	.114	10.7	1.03				
$3x10^9$	----	----	----	----	-----	----	----	----	12	.012	.90	.04				

a. Gen. Ceramics and Steatite. b. Data partly from Rado, Wright and Emerson, Phys. Rev. 80, 273 (1950).

I. Solids, A. Inorganic (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

3. Glasses	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Phosphate Glass #2043x[a]	25	ϵ'/ϵ_o	5.25	5.25	5.25	5.25	5.25	5.25	5.24	5.23	5.17	5.00	4.93
		tan δ	22	18	16	15	14	16	20	25	46	42	34
Phosphate Glass #2279x[b]	25	ϵ'/ϵ_o	4.92	4.92	4.92	4.92	4.92	4.92	4.92	----	4.9	4.9	4.9
		tan δ	26	19	16	14	14	13	14	----	18	19	21
Borosilicate Glass[c]	25	ϵ'/ϵ_o	4.05	4.05	4.05	4.05	4.05	4.05	4.05	----	4.05	4.05	
		tan δ	13.6	8.6	4.4	4.4	5.8	7.0	8.0	----	10.6	15.5	
Corning 0010[d]	24	ϵ'/ϵ_o	6.68	6.63	6.57	6.50	6.43	6.39	6.33	-----	6.1	5.96	5.87
		tan δ	77.5	53.5	35	23	16.5	15	23	-----	60	90	110
Corning 0014[e]	25	ϵ'/ϵ_o	6.78	6.77	6.76	6.75	6.73	6.72	6.70	6.69	----	5.64	
		tan δ	23.1	17.2	14.4	12.2	12.4	13.8	17.0	19.5	----	70	
Corning 0080[f]	23	ϵ'/ϵ_o	8.30	7.70	7.35	7.08	6.90	6.82	6.75	-----	6.71	6.71	6.62
		tan δ	780	400	220	140	100	85	90	-----	126	170	180
Corning 0090[g]	20	ϵ'/ϵ_o	9.15	9.15	9.15	9.14	9.12	9.10	9.02	-----	8.67	8.45	8.25
		tan δ	12	8	7	7	8	12	18	-----	54	103	122
Corning 0100[h]	25	ϵ'/ϵ_o	7.18	7.17	7.16	7.14	7.10	7.10	7.07	-----	7.00	6.95	6.87
		tan δ	24	16	13.5	13	14	17	24	-----	44	63	106
Corning 0120[i]	23	ϵ'/ϵ_o	6.75	6.70	6.66	6.65	6.65	6.65	6.65	-----	6.64	6.60	6.51
		tan δ	46	30	20	14	12	13	18	-----	41	63	127
Corning 1770[j]	25	ϵ'/ϵ_o	6.25	6.16	6.10	6.03	6.00	6.00	6.00	-----	5.95	5.83	5.44
		tan δ	49.5	42	33	26	27	34	38	-----	56	84	140
Corning 1990[k]	24	ϵ'/ϵ_o	8.40	8.38	8.35	8.32	8.30	8.25	8.20	-----	7.99	7.94	7.84
		tan δ	4	4	3	4	5	7	9	-----	19.9	42	112
Corning 1991[m]	24	ϵ'/ϵ_o	8.10	8.10	8.08	8.08	8.08	8.06	8.00	-----	7.92	7.83	
		tan δ	12	9	6	5	5	7	12	-----	38	51	
Corning 3320[n]	24	ϵ'/ϵ_o	5.00	4.93	4.88	4.82	4.79	4.78	4.77	-----	4.74	4.72	4.7
		tan δ	80	58	43	34	30	30	32	-----	55	73	120
Corning 7040[o]	25	ϵ'/ϵ_o	4.84	4.82	4.79	4.77	4.73	4.70	4.68	-----	4.67	4.64	4.52
		tan δ	50	34	25.5	20.5	19	22	27	-----	44	57	73
Corning 7050[p]	25	ϵ'/ϵ_o	4.88	4.84	4.82	4.80	4.78	4.76	4.75	-----	4.74	4.71	4.64
		tan δ	81	56	43	33	27	28	35	-----	52	61	83

a. Contains 2% iron oxide (Am. Optical). b. Aluminum-zinc phosphate. (ca. 70% P_2O_5)(Am. Optical). c. 73.2% SiO_2, 24.8% B_2O_3 (Components and Systems Lab., Air Materiel Command). d. Soda-potash-lead silicate ca. 20% PbO. e. Lead-barium glass. f. Soda-lime-silicate. g. Potash-lead-silicate. h. Potash-soda-barium silicate. i. Soda-potash-lead-silicate. j. Lime-alumina-silicate. k. Iron-sealing glass. m. 45% SiO_2, 14% K_2O, 6% Na_2O, 3% PbO, 5% CaO (iron-sealing glass). n. Soda-potash-borosilicate. o. Soda-potash-borosilicate. p. Soda-borosilicate (ca. 70% SiO_2).

I. Solids, A. Inorganic (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

3. Glasses (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Corning 7052[a]	23	ϵ'/ϵ_o	5.20	5.18	5.14	5.12	5.10	5.10	5.09	----	5.04	4.93	4.85
		tan δ	68	49	34	26	24	28	34	----	58	81	114
Corning 7055	25	ϵ'/ϵ_o	5.45	5.41	5.38	5.33	5.31	5.30	5.27	5.25	----	5.08	
		tan δ	45	36	30	28	28	29	38	49	----	130	
Corning 7060[b]	25	ϵ'/ϵ_o	5.02	4.97	4.92	4.86	4.84	4.84	4.84	----	4.82	4.80	4.65
		tan δ	89	55	42	40	36	30	30	----	54	98	90
Corning 7070[c]	23	ϵ'/ϵ_o	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.9
		tan δ	6	5	5	6	8	11	12	12	12	21	31
	100	ϵ'/ϵ_o	4.17	4.16	4.15	4.14	4.13	4.10	----	----	4.00	4.00	
		tan δ	50	22	13	10	9	11	----	----	19	21	
Corning 7230[d]	25	ϵ'/ϵ_o	3.88	3.86	3.85	3.85	3.85	3.85	----	----	3.75		
		tan δ	33	23	16	13	11	12	----	----	22		
Corning 7570	25	ϵ'/ϵ_o	14.58	14.56	14.54	14.53	14.52	14.50	14.42	14.4	----	14.2	
		tan δ	11.5	13.5	15.9	16.5	19.0	23.5	.33	44	----	98	
Corning 7720[e]	24	ϵ'/ϵ_o	4.74	4.70	4.67	4.64	4.62	4.61	----	----	----	4.59	
		tan δ	78	42	29	22	20	23	----	----	----	43	
Corning 7740[f]	25	ϵ'/ϵ_o	4.80	4.73	4.70	4.60	4.55	4.52	4.52	----	----	4.52	4.50
		tan δ	128	86	65	54	49	45	45	----	----	85	96
Corning 7750[f]	25	ϵ'/ϵ_o	4.45	4.42	4.39	4.38	4.38	4.38	----	----	4.38	4.38	
		tan δ	45	33	24	20	18	19	----	----	43	54	
Corning 7900[g]	20	ϵ'/ϵ_o	3.85	3.85	3.85	3.85	3.85	3.85	----	3.85	3.84	3.82	3.82
		tan δ	6	6	6	6	6	6	----	6	6.8	9.4	13
	100	ϵ'/ϵ_o	3.85	3.85	3.85	3.85	3.85	3.85	----	3.85	3.84	3.82	
		tan δ	37	17	12	10	8.5	7.5	----	7.5	10	13	
Corning 7911	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	3.82	
		tan δ	----	----	----	----	----	----	----	----	----	6.5	
Corning 8460[h]	25	ϵ'/ϵ_o	8.35	8.30	8.30	8.30	8.30	8.30	8.30	----	8.10	8.06	8.05
		tan δ	11	9	7.5	7	8	10	16	----	40	57	60
Corning 8830	25	ϵ'/ϵ_o	5.38	5.28	5.20	5.11	5.05	5.01	5.00	4.97	----	4.83	
		tan δ	204	130	91	73	60	54	57	63	----	99	

a. Soda-potash-lithia-borosilicate. b. Soda-borosilicate (Pyrex). c. Low alkali potash-lithia-borosilicate. d. Aluminum borosilicate. e. Soda-lead borosilicate. f. Soda-borosilicate (ca. 80% SiO_2). g. 96% SiO_2. h. Barium borosilicate.

I. Solids, A. Inorganic (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

3. Glasses (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Corning 8871[a]	25	ϵ'/ϵ_o	8.45	8.45	8.45	8.45	8.45	8.43	----	8.40	8.34	8.05	7.82
		tan δ	18	13	9	7	6	7	----	14	26	49	70
Corning 9010	25	ϵ'/ϵ_o	6.51	6.49	6.48	6.45	6.44	6.43	6.42	6.40	----	6.27	
		tan δ	50.5	36.2	26.7	22.7	21.5	22.6	30	41	----	91	
Corning Lab. No. 189CS	25	ϵ'/ϵ_o	19.2	19.2	19.2	19.1	19.0	19.0	19.0	----	17.8		
		tan δ	12.5	13	16.5	21	27	37	57	----	124		
" E " Glass[b]	23	ϵ'/ϵ_o	6.43	6.40	6.39	6.37	6.32	6.25	6.22	----	----	6.11	
		tan δ	42	34	27	18	15	17	23	----	----	60	
Foamglas[c]	23	ϵ'/ϵ_o	90.0	82.5	68.0	44.0	17.5	9.0	----	----	----	5.49	
		tan δ	1500	1600	2380	3200	3180	1960	----	----	----	455	
Fused Silica 915c[d]	25	ϵ'/ϵ_o	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78	----	3.78	
		tan δ	6.6	2.6	1.1	0.4	0.1	0.1	0.3	0.5	----	1.7	
Fused Silica 915c[d,e]	25	ϵ'/ϵ_o	3.78	3.78	3.78								
		tan δ	0.08	0.13	< 0.05								
Fused quartz[f]	25	ϵ'/ϵ_o	3.78	3.78	3.78	3.78	3.78	3.78	3.78	----	3.78	3.78	3.78
		tan δ	8.5	7.5	6	4	2	1	1	----	0.6	1	2.5
Soda-Silica Glasses[g]													
9% Na_2O, 91% SiO_2	25	ϵ'/ϵ_o	6.4	6.2	5.7	----	5.4	----	----	5.1	----	5.05	4.9
		tan δ	2500	820	400	----	130	----	----	100	----	130	160
12% Na_2O, 88% SiO_2	25	ϵ'/ϵ_o	8.2	6.7	6.1	----	5.6	----	----	5.2	----	5.15	5.04
		tan δ	1900	600	300	----	150	----	----	100	----	155	170
16% Na_2O, 84% SiO_2	25	ϵ'/ϵ_o	9.4	7.4	6.6	6.2	5.9	5.7	----	5.5	----	5.27	
		tan δ	3000	960	500	250	165	130	----	110	----	180	
20% Na_2O, 80% SiO_2	25	ϵ'/ϵ_o	10.8	8.3	7.3	6.8	6.6	6.3	----	5.9	----	5.6	6.1
		tan δ	4000	1500	670	360	220	180	----	140	----	200	280
25% Na_2O, 75% SiO_2	25	ϵ'/ϵ_o	13	9.7	8.4	----	7.6	----	----	6.7	----	6.3	
		tan δ	6700	2400	1000	----	310	----	----	170	----	220	
30% Na_2O, 70% SiO_2	25	ϵ'/ϵ_o	18	12	10.4	----	8.5	----	----	7.5	----	7.2	7.0
		tan δ	11000	3900	1300	----	400	----	----	190	----	240	350

a. Alkaline lead silicate. b. Owens-Corning. c. Soda-lime (Pittsburgh-Corning). d. SiO_2 (Corning). e. Sample B-135.
f. SiO_2 (General Electric). g. Composition in mole % of oxides as mixed (Lab. Ins. Res.).

I. Solids, A. Inorganic (Cont.)   Values for tan δ are multiplied by 10^4; frequency given in c/s.

3. Glasses (cont.) Alkali-silica glasses[a]	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
12.8% Li_2O, 87.2% SiO_2	25	ϵ'/ϵ_o	9.94	6.54	5.45	5.1	4.95	4.92	----	4.9	----	4.80
		tan δ	9700	3600	1000	310	174	124	----	79	----	102
12.8% Na_2O, 87.2% SiO_2	25	ϵ'/ϵ_o	8.09	6.61	6.00	5.8	5.66	5.57	----	5.4	----	5.33
		tan δ	3050	1370	450	240	159	126	----	118	----	182
12.8% K_2O, 87.2% SiO_2	25	ϵ'/ϵ_o	7.53	6.49	6.25	6.17	6.09	6.02	----	5.8	----	5.8
		tan δ	502	360	200	121	90	80	----	99	----	220
12.8% K_2O, 87.2% SiO_2	25	ϵ'/ϵ_o	7.10	6.63	6.30	6.12	6.10	6.08	----	5.95	----	5.75
Quenched		tan δ	730	470	270	160	119	103	----	106	----	240
12.8% Rb_2O, 87.2% SiO_2	25	ϵ'/ϵ_o	5.39	5.32	5.23	5.22	5.21	5.20	----	5.15	----	5.05
		tan δ	98	89	58	46	41	38	----	59	----	120
6.4% Li_2O, 6.4% Na_2O,	25	ϵ'/ϵ_o	5.15	5.08	5.05	5.05	5.04	5.03	----	5.00	----	4.95
87.2% SiO_2		tan δ	145	87	47	28	19	17	----	26	----	52
6.4% Li_2O, 6.4% Na_2O,	25	ϵ'/ϵ_o	5.15	5.09	5.05	5.05	5.04	5.02	----	4.98	----	4.94
87.2% SiO Quenched		tan δ	150	87	47	27	19	21	----	31	----	57
3.3% Li_2O, 6.6% K_2O,	25	ϵ'/ϵ_o	5.23	5.19	5.17	5.15	5.14	5.10	----	5.07	----	5.04
71% SiO_2		tan δ	53	47	37	28	24	24	----	40	----	83
3.3% Li_2O, 6.6% K_2O,	25	ϵ'/ϵ_o	5.38	5.35	5.28	5.26	5.23	5.20	----	5.15	----	5.08
91% SiO_2 Quenched		tan δ	102	74	44	30	30	33	----	49	----	102
6.4% Na_2O, 6.4% K_2O,	25	ϵ'/ϵ_o	5.68	5.62	5.58	5.56	5.56	5.54	----	5.51	----	5.50
87.2% SiO_2		tan δ	102	75	42	31	25	23	----	40	----	115
6.4% Na_2O, 6.4% K_2O,	25	ϵ'/ϵ_o	5.70	5.62	5.58	5.56	5.56	5.55	----	5.54	----	5.53
87.2% SiO_2 Quenched		tan δ	129	89	47	36	33	34	----	44	----	160

a. Composition in mole % of oxides as mixed (Lab. Ins. Res.)

I. Solids A. Inorganic (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

	$T^{o}C$		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
4. Mica and Glass													
Mycalex 2821[a]	25	ϵ'/ϵ_o	7.50	7.50	7.50	7.50	7.50	7.45	7.45	----	----	7.09	
(discontinued)		tan δ	60	28	17	13	10	9	9	----	----	27	
Mycalex 400[b]	25	ϵ'/ϵ_o	7.47	7.45	7.42	7.40	7.39	7.38	----	----	----	7.12	
		tan δ	29	19	16	14	13	13	----	----	----	33	
	80	ϵ'/ϵ_o	7.64	7.59	7.54	7.52	7.50	7.47	----	----	----	7.32	
		tan δ	150	85	50	25	16	14	----	----	----	57	
Mycalex K10[c]	24	ϵ'/ϵ_o	9.5	9.3	9.2	9.1	9.0	9.0	----	----	11.3*	11.3*	
		tan δ	170	125	76	42	26	21	----	----	40	40	
Mykroy Grade 8[d]	25	ϵ'/ϵ_o	6.87	6.81	6.76	6.74	6.73	6.73	6.72	----	6.68**	6.96**	6.66
		tan δ	95	66	43	33	26	24	25	----	38	48	81
Mykroy Grade 38[d]	25	ϵ'/ϵ_o	7.71	7.69	7.64	7.61	7.61	7.61	----	----	7.68**	8.35**	
		tan δ	43	33	27	24	21	14	----	----	35	40	
5. Miscellaneous Inorganics													
Ruby mica[e]	26	ϵ'/ϵ_o	5.4	5.4	5.4	5.4	5.4	5.4	5.4	----	5.4		
		tan δ	25	6	3.5	3	3	3	2	----	3		
Canadian mica	25	ϵ'/ϵ_o	6.90	6.90	6.90								
(field ⊥ sheet)		tan δ	15	2	1								
(field ∥ sheet)	25	ϵ'/ϵ_o	11.5	8.7	7.3								
		tan δ	2300	980	400								
Marble S-3030[f] (after drying over P_2O_5)	25	ϵ'/ϵ_o	15.6	12.8	11.4	10.6	10.0	9.5	9.1	8.8	----	8.6	
		tan δ	2000	1100	630	390	360	370	290	250	----	120	
(after baking)	25	ϵ'/ϵ_o	9.45	9.42	9.29	9.25	9.07	8.98	8.85	----	----	8.53	
		tan δ	180	130	81	75	110	120	120	----	----	110	
(after 60% humidity for 3 weeks)	25	ϵ'/ϵ_o	----	----	----	----	----	9.35	8.95				
		tan δ	----	----	----	----	----	500	250				
Selenium, amorphous[g]	25	ϵ'/ϵ_o	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.0	6.00	6.00	6.00
		tan δ	18	4	< 3	< 5	< 3	< 2	< 2	< 5	1.8	6.7	13
Quinterra[h] (Measured at 50% R.H.)	25	ϵ'/ϵ_o	5.75	4.80	4.1	3.3	3.1						
		tan δ	1770	1500	1240	590	250						
Quinorgo #3000[i]	25	ϵ'/ϵ_o	8.75	6.4	4.9	4.0	3.3						
(Measured at 50% R.H.)		tan δ	2[illegible]10	2310	2150	1350	870						

a. Mica, glass (Gen. Elec.). b. Mica, glass (Mycalex). c. Mica, glass, TiO_2 (Mycalex). d. Mica, glass (Electronic Mech.).
e. Muscovite. f. Class A (Tenn. Marble). g. Amer. Smelt. and Refining. h. Asbestos fiber, chrysotile, Type I (Johns-Manville).
i. 85% chrysotile asbestos, 15% organic material (Johns-Manville).
*Not corrected for variations of density. **Samples nonhomogeneous.

I. Solids A. Inorganic (cont.)

5. Misc. Inorganics

Values for tan δ are multiplied by 10^4; frequency given in c/s.

(cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Sandy soil, dry	25	ϵ'/ϵ_o	3.42	2.91	2.75	2.65	2.59	2.55	----	2.55	2.55	2.53
		tan δ	.196	.08	.034	.020	.017	.016	----	.0100	.0062	.0036
2-18% moisture	25	ϵ'/ϵ_o	3.23	2.72	2.50	2.50	2.50	2.50	----	2.50	2.50	2.50
		tan δ	.64	.13	.056	.030	.025	.025	----	.026	.03	.065
3.88% moisture	25	ϵ'/ϵ_o	----	----	----	5.0	4.70	4.50	----	4.50	4.40	3.60
		tan δ	----	1500	----	19	1.75	.3	----	.03	.046	.12
16.8% moisture	25	ϵ'/ϵ_o	----	----	----	----	20	20	----	20	20	13
		tan δ	----	3425	367	----	4	.35	----	.03	.13	.29
Loamy soil, dry	25	ϵ'/ϵ_o	3.06	2.83	2.69	2.60	2.53	2.48	----	2.47	2.44	2.44
		tan δ	.07	.05	.035	.03	.018	.014	----	.0065	.0011	.0014
2.2% moisture	25	ϵ'/ϵ_o	----	----	18	----	6.9	4	----	3.5	3.5	3.50
		tan δ	----	2.1	1.6	----	.65	.45	----	.06	.04	.03
13.77% moisture	25	ϵ'/ϵ_o	----	----	----	----	----	14.5	----	20	20	13.8
		tan δ	----	8490	970	----	----	1.3	----	.16	.12	.18
Clay soil, dry	25	ϵ'/ϵ_o	4.73	3.94	3.27	2.79	2.57	2.44	----	2.38	2.27	2.16
		tan δ	.12	.12	.12	.10	.065	.04	----	.020	.015	.013
20.09% moisture	25	ϵ'/ϵ_o	----	----	----	----	----	21.6	----	20	11.3	
		tan δ	----	7800	1000	----	----	1.7	----	.52	.25	
Magnetite soil, dry	25	μ'/μ_o	----	----	----	----	1.09	1.09	----	1.09	1.005	
		tan δ_m	----	----	----	----	----	----	----	.025	.099	
	25	ϵ'/ϵ_o	3.95	3.75	3.62	3.52	3.50	3.60	----	3.50	3.50	
		tan δ_d	.041	.029	.022	.017	.015	.012	----	.018	.022	
4.8% moisture	25	ϵ'/ϵ_o	----	----	----	----	12	10	----	9.0	8.3	
		tan δ_d	----	$\rho = 2x10^5$ ohm cm			9	1.0	----	.12	.22	
11.2% moisture	25	ϵ'/ϵ_o	----	----	----	----	----	30	----	30	30	
		tan δ_d	----	$\rho = 2x10^4$ ohm cm			----	4	----	.2	.32	
Amplifilm[a]	25	ϵ'/ϵ_o	4.34	4.32	4.30	4.30	4.30	4.29				
		tan δ	.00314	.0022	.0019	.0017	.0017	.0018				

a. Bentonite with organic binder (Aircraft Marine).

I. Solids, B. Organic, with or without inorganic components - Values for tan δ are multiplied by 10^4; frequency given in c/s.

	$T^{o}C$		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
1. Crystals													
α-Trinitrotoluene[a]	26	ϵ'/ϵ_o	2.64	2.64	2.64	2.64	2.64	2.64					
		tan δ	36	20	11	6	4.5	4					
α-Trinitrotoluene at ca. 20% humidity[b]	25	ϵ'/ϵ_o	3.80	3.09	2.93	2.90	2.89	2.89	2.89	2.89	2.86	2.82	
		tan δ	2600	900	200	40	20	17	28	39	18	14	
Santicizer 9[c]	25	ϵ'/ϵ_o	4.19	3.76	3.56	3.51	3.47	3.43	3.35	-----	-----	------	3.21
		tan δ	1140	560	350	185	120	110	71	-----	-----	------	28
Naphthalene[d]	25	ϵ'/ϵ_o	-----	2.85	2.85	2.85	2.85	2.85	-----	-----	2.8		
		tan δ	-----	19	9	5	3	2	-----	-----	2.1		
Orthoterphenyl[e]	25	ϵ'/ϵ_o	2.8	2.8	2.8	2.8	2.8	2.8	-----	------	-----	2.74	
		tan δ	3.7	4.7	6.0	6.3	6	5	-----	-----	-----	2.7	
Metaterphenyl[e]	25	ϵ'/ϵ_o	-----	2.86	2.86	-----	2.86	2.86	2.86	-----	2.83		
		tan δ	-----	4.5	4.5	-----	9.5	10.1	5	-----	0.7		
Paraterphenyl[e]	25	ϵ'/ϵ_o	-----	(2.95-3.20 depending on degree of crystallization)						-----	2.95		
		tan δ	-----	2	1	< 2	< 2	< 2	< 2	-----	2.1		
Aroclor 1268[f]	25	ϵ'/ϵ_o	2.64	2.64	2.64	2.64	2.64	2.64					
		tan δ	14	3.5	2	< 3	< 6	< 6					
2. Simple Noncrystals													
Aroclor 5460[g]	25	ϵ'/ϵ_o	2.43	2.43	2.42	2.42	2.41	2.41	2.41				
		tan δ	< 3	4	16	20	18	13	8				
Aroclor 4465[h]	25	ϵ'/ϵ_o	2.81	2.80	2.79	2.79	2.79	2.79	2.79				
		tan δ	45	17	6.6	4	2.4	1.5	1.0				
3. Plastics													
a. Phenol-formaldehyde													
Bakelite BM-120[i]	25	ϵ'/ϵ_o	4.87	4.74	4.62	4.50	4.36	4.16	3.95	-----	3.70	3.68	3.55
(preformed and preheated)		tan δ	300	220	200	210	280	350	380	-----	438	410	390

a. Chem. Lab. M.I.T. b. War Dept., Picatinny Arsenal. c. o- and p-toluene sulfonamides (Monsanto). d. Eastman Kodak: recryst. and resubl. Lab. Ins. Res. e. Monsanto, recryst. Lab. Ins. Res. f. Nonachlorobiphenyl (Monsanto). g. Nonachloroterphenyls (Monsanto). h. Chlorinated mixture of biphenyl and terphenyl (Monsanto). i. 46% wood flour, 8% misc. (Bakelite).

I. Solids, B. Organic (cont.)

3. Plastics (cont.)

a. Phenol-formaldehyde (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Bakelite BM-120[a]	27	ϵ'/ϵ_o	5.50	5.15	4.90	4.65	4.45	4.30	----	----	3.70	3.55	
(not preformed or preheated)		tan δ	740	460	345	320	350	415	----	----	400	500	
	57	ϵ'/ϵ_o	7.80	6.35	5.70	5.30	4.90	4.65	4.5	----	4.15		
		tan δ	2950	1150	530	380	430	470	480	----	530		
	88	ϵ'/ϵ_o	18.2	8.5	6.5	5.7	5.2	5.0	4.7	----	4.40		
		tan δ	7600	3700	1400	600	400	420	470	----	700		
Bakelite BM-250[b]	25	ϵ'/ϵ_o	37	22	12	7.2	5.3	5.0	----	----	----	----	5.0
(preformed and preheated)		tan δ	3000	3700	3900	2900	1250	220	----	----	----	----	320
Bakelite BT-48-306[c]	24	ϵ'/ϵ_o	8.2	7.15	6.5	5.9	5.4	4.9	4.4	----	3.64	3.52	
		tan δ	1350	820	630	560	600	730	770	----	519	366	
Bakelite BM-16981[d]	25	ϵ'/ϵ_o	7.6	6.1	5.4	5.1	4.9	4.8	4.7	----	4.6	4.5	
(not preformed or preheated)		tan δ	2300	1000	500	300	200	130	100	----	100	120	
Bakelite BM-16981[d]	25	ϵ'/ϵ_o	4.82	4.73	4.66	4.62	4.60	4.59	4.58	----	4.57	4.57	
(preformed and preheated)		tan δ	140	120	100	70	52	50	60	----	90	85	
Bakelite BM-16981[d]	25	ϵ'/ϵ_o	5.05	4.87	4.80	4.79	4.72	4.67	4.62	----	----	4.52	
(powder preheated)		tan δ	190	160	130	90	72	60	56	----	----	82	
Laminated Fiberglas	24	ϵ'/ϵ_o	14.2	9.8	7.2	5.9	5.3	5.0	4.8	4.54	4.40	4.37	
BK-174[e]		tan δ	2500	2600	1600	880	460	340	260	240	290	360	
Catalin 200 base, white[f]	22*	ϵ'/ϵ_o	8.6	8.2	7.9	7.5	7.0	6.5	----	----	4.89		
		tan δ	400	290	330	400	500	650	----	----	1080		
	85*	ϵ'/ϵ_o	53.5	34	24	17	12	9.5	----	----	5.81		
		tan δ	98000	20000	5200	1800	1000	1100	----	----	1910		
	25**	ϵ'/ϵ_o	6.9	6.7	6.6	6.5	6.3	5.8	----	5.1	4.61		
		tan δ	130	170	260	330	380	480	----	878	926		

a. 46% wood flour, 8% misc. (Bakelite). b. 66% asbestos fiber (Bakelite). c. 100% (Bakelite). d. Mica-filled (Bakelite).

e. 31.6% Bakelite's BV-17085, 68.4% Fiberglas (Owens Corning). f. Catalin.

* Measured December, 1943. **Same material measured after two years at room temperature and humidity.

I. Solids, B. Organic 3. Plastics (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

a. Phenol-formaldehyde (cont.)

	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Catalin 500 base,	22*	ϵ'/ϵ_o	9.7	9.4	8.8	8.1	7.3	6.3	----	4.90	4.72		
yellow[a]		tan δ	280	320	400	550	760	1200	----	996	870		
	25**	ϵ'/ϵ_o	4.92	4.86	4.78	4.69	4.57	4.40	4.2	4.02	3.7	3.41	
		tan δ	66	100	150	230	330	460	580	620	520	360	
Catalin 500 base,	25	ϵ'/ϵ_o	20.0	15.2	12.6	10.8	9.6	8.4	----	5.79	4.77	4.43	
standard[a]		tan δ	2800	1500	1000	860	940	1200	----	1540	1250	1300	
Catalin 700 base	25*	ϵ'/ϵ_o	94	44	16	11	8	6	----	----	4.74		
(Prystal)[a]		tan δ	16500	8000	4100	2300	1600	1400	----	----	1530		
	80*	ϵ'/ϵ_o	----	----	51	18.5	10.0	7.4	----	----	4.77		
		tan δ	----	----	13200	6600	3700	2400	----	----	1640		
	25**	ϵ'/ϵ_o	58	24	14	9.6	8.0	6.6	5.0	4.1	3.7		
		tan δ	14000	6400	3100	1900	1500	1400	950	740	500		
Durez 1601, natural[b]	26	ϵ'/ϵ_o	5.09	4.94	4.80	4.68	4.60	4.55	4.51	----	4.48	4.47	
		tan δ	270	210	132	100	80	70	64	----	62	62	
Durite 500[c]	24	ϵ'/ϵ_o	5.10	5.03	4.95	4.86	4.78	4.72	4.72	----	4.71	4.70	
		tan δ	130	104	86	78	82	102	115	----	126	128	
Formica XX[d]	26	ϵ'/ϵ_o	5.23	5.15	4.96	4.78	4.60	4.32	4.04	----	3.57***	3.55+	
(field ⊥ to laminate)		tan δ	230	165	170	230	340	490	570	----	600***	700+	
Formica LE[e]	26	ϵ'/ϵ_o	6.50	5.70	5.30	5.00	4.75	4.35	3.95	----	3.35***	3.25+	
(field ⊥ to laminate)		tan δ	1350	600	430	400	410	480	500	----	400***	460+	
Grade YN-25[f]	25	ϵ'/ϵ_o	3.73	3.65	3.61	3.61	3.59	3.47	----	3.24++	3.20	3.12	
(field ‖ to laminate)		tan δ	121	132	200	207	187	187	----	183++	178	173	
	25	ϵ'/ϵ_o	3.87	3.77	3.68	3.61	3.55	3.47	----				
(field ⊥ to laminate)		tan δ	166	150	182	204	182	191					
Panelyte Grade 776[g]	25	ϵ'/ϵ_o	4.25	4.18	4.10	3.95	3.87	3.73	3.52	3.40	3.22	3.12	3.05
		tan δ	190	150	160	200	280	370	400	390	370	340	310

a. Catalin. b. 67% mica (Durez). c. 65% mica, 4% lubricants (Durite). d. 50% paper laminate (Formica). e. 40% cotton fabric (Formica). f. 50% Nylon fabric (Formica). g. Paper base (St. Regis).

*Measured December, 1943. **Same material measured after two years at room temperature and humidity. ***Rod stock in coaxial line. +Rod stock in H_{11} (TE_{11}) mode of circular guide. ++Freq. = 1 x 10^9.

I. Solids, B. Organic (Cont.).

3. Plastics (cont.)

a. Phenol-formaldehyde (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Micarta #254[a]	-13	ϵ'/ϵ_o	4.9	4.7	4.5	4.4	4.2	4.0	3.4	----	3.34	3.13	
		tan δ	250	220	240	280	370	390	370	----	286	215	
	25	ϵ'/ϵ_o	5.30	4.95	4.81	4.66	4.51	4.20	3.85	3.78	3.43	3.25	3.21
		tan δ	760	330	260	270	360	470	550	470	505	410	380
	82	ϵ'/ϵ_o	9.2	6.3	5.5	5.3	5.1	4.9	----	----	4.02	3.21	
		tan δ	4100	1820	690	360	300	400	----	----	984	773	
Micarta #496[b]	25	ϵ'/ϵ_o	8.6	7.0	6.3	5.6	5.2	4.8	4.38				
(field ⊥ to laminate)		tan δ	2200	1100	630	500	480	630	710				
Micarta #496[b]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	3.95*	3.78*	3.62*	
(field ∥ to laminate)		tan δ	----	----	----	----	----	----	----	510*	550*	570*	
Phenolic paper laminate	25	ϵ'/ϵ_o	4.21	4.17	4.12	4.06	3.94	3.81	3.62				
JH-1410[c]		tan δ	146	100	115	162	222	295	339				
Resinox 10231[d]	25	ϵ'/ϵ_o	11.4	9.3	7.6	6.2	5.4	5.0	4.8	4.8**	4.7	4.6	
		tan δ	1390	1410	1440	1180	700	400	290	310**	330	340	
Resinox 10900[e]	25	ϵ'/ϵ_o	4.80	4.64	4.45	4.37	4.24	4.23	4.08	4.05**	4.03	4.02	
		tan δ	275	270	230	180	135	110	93	93**	100	96	
Taylor Grade GGG[f]	25	ϵ'/ϵ_o	7.25	6.08	4.67	4.14	4.00	3.9	3.9	3.9**	3.9	3.9	
(field ∥ laminate)		tan δ	1300	1600	1500	500	150	110	140	200**	250	290	
(field ⊥ laminate)	25	ϵ'/ϵ_o	3.95	3.91	3.85	3.82	3.75	3.68	3.64				
		tan δ	119	88	91	104	110	114	110				
Dilecto (Mecoboard)[g]	25	ϵ'/ϵ_o	4.20	3.98	3.79	3.62	3.46	3.37	3.23	3.18	3.11	3.08	
		tan δ	400	344	318	304	263	223	216	215	220	229	
	90	ϵ'/ϵ_o	11.90	8.40	6.23	5.60	5.32	4.34	----	3.35	----	3.30	
		tan δ	2310	1640	1020	584	570	970	----	660	----	470	

a. Cresylic acid-formaldehyde, 50% α-cellulose (Westinghouse). b. Cresylic acid-formaldehyde, 50% cotton drilling. (Westinghouse).
c. 35% paper (Catalin). d. 53% filler (Monsanto). e. 35% mica, 18% filler (Monsanto). f. 40% random glass mat (Taylor).
g. 45% cresol-phenol formaldehyde, 15% tung oil, 15% nylon (Continental Diamond).
*Samples turned from sheet stock. **Freq = 1 x10^9.

I. Solids, B. Organic (Cont.)

3. Plastics (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

a. Phenol-formaldehyde (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Dilecto (hot punching)	25	ϵ'/ϵ_o	14.7	8.61	6.68	5.76	5.05	4.60	4.10	3.78	3.45	3.35
XXX-P-26[a]		tan δ	6420	2970	1380	840	720	705	690	680	500	480
(Field ∥ sheet)	90	ϵ'/ϵ_o	----	----	----	----	----	----	----	4.36	----	3.72
		tan δ	----	----	----	----	----	----	----	950	----	770
	120	ϵ'/ϵ_o	----	----	----	----	----	----	----	4.76	----	4.27
		tan δ	----	----	----	----	----	----	----	990	----	820
(Field ⊥ sheet)	25	ϵ'/ϵ_o	4.29	4.21	4.14	4.01	3.89	3.73	3.56	3.35		
		tan δ	137	119	137	180	250	340	390	440		
	90	ϵ'/ϵ_o	5.74	5.09	4.77	4.57	4.32	4.16				
		tan δ	1990	620	360	284	273	308				
	120	ϵ'/ϵ_o	7.42	5.38	4.80	4.52	4.34	4.21				
		tan δ	6700	1910	630	380	290	322				
Micarta #299[b]	24	ϵ'/ϵ_o	5.36	5.29	5.20	5.10	5.01	4.92	4.80			
(field ⊥ to laminate)		tan δ	270	130	115	122	138	150	170			
Micarta #299[b]	24	ϵ'/ϵ_o	----	----	----	----	----	----	----	4.54*	4.34*	4.59**
(field ∥ to laminate)		tan δ	----	----	----	----	----	----	----	149*	188*	230**
Durite #221X[c]	24	ϵ'/ϵ_o	6.70	5.70	5.30	4.90	4.55	4.30	4.15	----	3.65	
		tan δ	2000	820	520	470	430	400	390	----	350	
	84	ϵ'/ϵ_o	13.8	7.0	5.8	5.2	4.9	4.5	4.3	----	3.72	
		tan δ	9000	3300	1200	550	460	470	420	----	800	
Corfoam 114[d]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	1.36
		tan δ	----	----	----	----	----	----	----	----	----	750
Expanded plastic board	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	1.21	
CP-7B[e]		tan δ	----	----	----	----	----	----	----	----	80	
Expanded phenolic board	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	1.185	
(dark)[e]		tan δ	----	----	----	----	----	----	----	----	58	

a. 45% cresol-phenol formaldehyde, 15% tung oil, 40% α paper (Conti. Diamond). b. Cresylic acid-formaldehyde, 60-65% glass fabric (Westinghouse). c. Phenol-furfuraldehyde (Durite). d. Expanded phenolic, den. 0.202 (Rezolin). e. Sponge Rubber Prod.

*Stacked sheets in coaxial line. **Stacked sheets in H_{11} (TE_{11}) mode of circular guide.

I. Solids, B. Organic (Cont.)

3. Plastics (cont.)

b. Phenol-aniline-formaldehyde

Values for tan δ are multiplied by 10^4; frequency given in c/s.

	$T^\circ C$		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Bakelite BM-262[a]	25	ϵ'/ϵ_o	4.85	4.80	4.74	4.72	4.67	4.66	4.65	----	----	4.55	4.5
(preformed and preheated)		tan δ	98	82	75	60	55	55	57	----	----	105	89
Bakelite BM-262[a]	26	ϵ'/ϵ_o	4.9	4.8	4.75	4.7	4.7	4.65	4.65	----	4.58	4.45	
(not preformed or preheated)		tan δ	235	165	113	83	70	65	80	----	90	104	
	84	ϵ'/ϵ_o	5.8	5.4	5.1	5.0	4.9	4.8	4.7	----	4.58	----	
		tan δ	680	440	280	210	160	135	120	----	120	----	
Bakelite BM-1895[b]	25	ϵ'/ϵ_o	4.80	4.72	4.70	4.67	4.64	4.61	4.58	4.55	4.53	4.43	4.35
(preformed and preheated)		tan δ	87	77	80	65	52	52	80	98	102	100	130
Bakelite BM-1895[b]	28	ϵ'/ϵ_o	5.0	4.9	4.75	4.65	4.55	4.5	4.5	----	4.44	4.44	
(not preformed or preheated)		tan δ	138	122	106	90	72	57	60	----	91	96	
	84	ϵ'/ϵ_o	5.8	5.3	5.0	4.8	4.65	4.6	4.6	----	4.6		
		tan δ	740	470	310	225	175	140	125	----	132		
Durez 11863[c]	-12	ϵ'/ϵ_o	4.68	4.59	4.52	4.48	4.42	4.39	----	----	4.32	4.31	
(preformed and preheated)		tan δ	97	84	66	52	43	38	----	----	44	47	
	25	ϵ'/ϵ_o	4.76	4.70	4.64	4.60	4.55	4.50	4.48	----	4.45	4.42	
		tan δ	108	100	82	62	52	48	52	----	69	76	
	80	ϵ'/ϵ_o	5.26	5.03	4.87	4.74	4.63	4.55	----	----	4.40	4.38	
		tan δ	504	290	195	145	125	113	----	----	100	106	
Durez 11863[c]	26	ϵ'/ϵ_o	5.44	5.22	5.04	4.90	4.78	4.69	----	----	4.52	4.49	
(not preformed or preheated)		tan δ	760	390	230	160	115	88	----	----	63	63	
Formica Grade MF-66 Fiberglas[d]	25	ϵ'/ϵ_o	4.53	4.50	4.43	4.38	4.31	4.24	4.11	4.09	3.90	3.88	3.85
		tan δ	106	95	107	102	95	109	160	195	260	290	300
	79	ϵ'/ϵ_o	4.94	4.75	4.66	4.59	4.51	4.44	4.35	----	4.20	4.10	
		tan δ	350	192	135	110	105	110	130	----	346	702	
Resinox 7934[e] (preformed and preheated)	25	ϵ'/ϵ_o	4.62	4.46	4.34	4.28	4.20	4.13	4.10	4.05	4.04	4.04	
		tan δ	220	210	178	130	99	88	85	84	84	83	

a. 62% mica (Bakelite). b. 59.5% mica, 8.5% misc. (Bakelite). c. 43% mica, 5% misc.; discontinued, substitute 12810 (Durez). d. 40% glass mat (Formica). e. 60% mica (Monsanto).

I. Solids, B. Organic (Cont.)

3. Plastics (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
c. Aniline-formaldehyde													
Cibanite E[a]	25	ϵ'/ϵ_o	3.58	3.57	3.56	3.48	3.41	3.41	3.41	----	3.40	3.40	
		tan δ	29	41	69	85	79	49	39	----	29	49	
Dilectene 100[b]	22	ϵ'/ϵ_o	3.6	3.6	3.55	3.55	3.5	3.5	3.5	----	3.44	----	3.42
(1943 product)		tan δ	33	45	76	90	72	41	32	----	39	----	56
	84	ϵ'/ϵ_o	3.6	3.6	3.6	3.6	3.55	3.5	3.5	----	3.44		
		tan δ	36.5	34	37	50	90	83	61	----	47		
Dilectene 100[b]	25	ϵ'/ϵ_o	3.68	3.68	3.66	3.60	3.58	3.50	3.50	----	3.44	3.44	
(1944 product)		tan δ	33	32	57	68	61	47	33	----	26	45	
d. Melamine-formaldehyde													
Formica Grade FF-41[c]	26	ϵ'/ϵ_o	6.15	6.00	5.95	5.85	5.75	5.65	5.5				
(sheet stock)		tan δ	400	119	86	93	115	165	200				
Formica Grade FF-41[c]	26	ϵ'/ϵ_o	----	----	----	3.7	3.7	3.65	3.6	----	----	3.3	
(rod stock)		tan δ	----	----	----	50	48	80	111	----	----	115	
Formica Grade FF-55[d]	24	ϵ'/ϵ_o	6.55	6.35	6.20	6.05	6.00	5.90	5.80	5.63	----	----	4.73
(field ⊥ to laminate)		tan δ	400	142	85	85	108	155	220	250	----	----	440
Formica FF-55[d]	24	ϵ'/ϵ_o	----	----	----	----	----	----	----	5.55*	5.31*	5.4**	4.8
(field ∥ to laminate)		tan δ	----	----	----	----	----	----	----	275*	328*	399**	345
GMG Melamine[e]	25	ϵ'/ϵ_o	8.2	7.0	6.7	6.6	6.4	6.3	6.1				
(field ⊥ to laminate)		tan δ	1900	690	190	100	110	180	230				
GMG Melamine[e]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	5.4			
(field ∥ to laminate)		tan δ	----	----	----	----	----	----	----	230			
Melmac Resin 592[f]	27	ϵ'/ϵ_o	6.70	6.25	5.85	5.50	5.20	4.90	4.70	----	4.67	4.59	
		tan δ	590	470	410	375	347	326	360	----	410	434	
	57	ϵ'/ϵ_o	8.15	6.95	6.35	5.85	5.40	5.10	4.90	----	4.75		
		tan δ	1250	750	490	400	350	320	350	----	480		
	88	ϵ'/ϵ_o	21.8	11.8	8.0	6.5	6.0	5.8	5.5	----	4.90		
		tan δ	7400	3400	1650	750	520	470	380	----	520		
Melmac Type 1077[g]	28	ϵ'/ϵ_o	7.00	6.90	6.75	6.50	6.20	5.90	----	----	4.8	4.7	
(Ivory WB 48)		tan δ	240	130	140	190	280	440	----	----	900	1000	

a. 100% (Ciba). b. 100% (Continental-Diamond). c. 55% filler (Formica). d. Glass fiber mat (Formica). e. Glass Lamicoid #6038 (Mica Insulator). f. Mineral filler (Am. Cyanamid). g. 25% alpha pulp, Zn stearate (Am. Cyanamid).

*Stacked sheets in coaxial line. ** Stacked sheets in H_{11} (TE_{11}) mode of circular guide.

I. Solids. B. Organic 3. Plastics (Cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

d. Melamine-formaldehyde (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Melmac Molding	25	ϵ'/ϵ_o	6.50	6.31	6.18	6.01	5.85	5.53	5.10	4.37*	4.20	4.10	
Compound 1500[a]		tan δ	303	173	162	221	320	415	500	523*	520	505	
Melmac Molding	25	ϵ'/ϵ_o	8.43	6.95	6.37	6.04	5.77	5.36	4.90	4.40*	4.20	4.00	
Compound 1502[b]		tan δ	2020	960	460	350	410	510	560	620*	620	520	
Polyglas M[c]	24	ϵ'/ϵ_o	5.58	5.53	5.49	5.40	5.32	5.22	----	----	4.86**	5.22**	
		tan δ	140	71	64	69	93	160	----	----	339**	660**	
	80	ϵ'/ϵ_o	8.4	6.5	5.9	5.8	5.8	5.8	----	----	5.68**	5.32**	
		tan δ	4000	1400	280	95	65	110	----	----	498**	721**	
Micarta #259[d]	24	ϵ'/ϵ_o	6.18	6.07	5.97	5.90	5.81	5.72	5.55	----	----	4.80++	
(field ⊥ to laminate)		tan δ	190	125	105	85	108	145	200	----	----	322++	
Micarta #259[d]	24	ϵ'/ϵ_o	----	----	----	----	----	----	----	4.83***	4.75***	5.12+	4.70++
(field ∥ to laminat)		tan δ	----	----	----	----	----	----	----	150***	260***	380+	400++
Panelyte 140[e]	24	ϵ'/ϵ_o	6.15	6.05	6.00	5.93	5.82	5.70	5.55	5.5	----	4.70	4.62
(field ⊥ to laminate)		tan δ	135	93	120	155	155	170	215	260	----	360	260
Panelyte 140[e]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	4.95	4.73	----	4.60
(field ∥ to laminate)		tan δ	----	----	----	----	----	----	----	210	250	----	260
Plaskon Melamine[f]	24	ϵ'/ϵ_o	7.73	7.57	7.40	7.26	7.00	6.45	6.0	5.73	4.93	4.60	
		tan δ	190	122	150	240	410	640	850	985	1028	1100	
	80	ϵ'/ϵ_o	9.86	8.7	8.4	8.4	7.9	7.5	7.0	----	5.5	5.04	
		tan δ	1800	560	210	140	220	410	700	----	1250	1490	
Resimene 803-A[g]	24	ϵ'/ϵ_o	7.05	6.90	6.75	6.50	6.20	5.70	5.20	5.04	4.53	4.23	
(not preformed or preheated)		tan δ	410	210	190	270	440	660	820	859	820	760	
Resimene 803-A[g]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	3.75	3.74
(powder preheated)		tan δ	----	----	----	----	----	----	----	----	----	320	300

a. 40% wood flour, 18% plasticizer (Am. Cyanamid). b. 60% melamine, formaldehyde and aniline polymer with wood flour filler (Am. Cyanamid). c. 56.5% Am. Cyanamid's Melmac 7278, 43.5% Owens-Corning's Glass "E" (Hood Rubber). d. 65-70% Fiberglas (Westinghouse). e. Fiberglas (St. Regis). f. α-cellulose (Libbey-Owens-Ford). g. 40% cellulose (Monsanto).

* Freq. = 1 x 10^9. ** Sample nonhomogenous; stacked layers. ***In coaxial lines. +In $H_{11}(TE_{11})$ mode circular guide. ++In H_{01} (TE_{01}) mode rectangular guide.

I. Solids. B. Organic 3. Plastics (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
e. Urea-formaldehyde													
Beetle Resin[a]	27	ϵ'/ϵ_o	6.5	6.2	6.05	5.9	5.65	5.4	5.1	----	4.57	4.47	
		tan δ	300	240	200	195	270	420	500	----	555	570	
Plaskon Urea, natural[b]	24	ϵ'/ϵ_o	7.1	6.7	6.4	6.2	6.0	5.7	5.2	5.1	4.79	4.65	
		tan δ	380	280	220	220	310	410	500	530	694	782	
	80	ϵ'/ϵ_o	8.8	7.8	7.4	7.1	6.8	6.6	----	----	5.54	4.27	
		tan δ	940	600	420	320	300	350	----	----	819	1630	
Plaskon Urea, brown[b]	24	ϵ'/ϵ_o	6.65	6.35	6.15	6.00	5.75	5.42	5.0	4.82	4.60	4.55	
		tan δ	320	260	240	250	280	350	420	438	527	742	
f. Benzoguanamine-formaldehyde													
Benzoguanamine Resin[c]	25	ϵ'/ϵ_o	4.72	4.58	4.50	4.40	4.26	4.15	3.96	3.62*	3.52	3.38	
		tan δ	348	189	127	140	196	273	320	342*	336	318	
g. Polyamide Resins													
Nylon 66[d]	25	ϵ'/ϵ_o	3.88	3.75	3.60	3.45	3.33	3.24	3.16	----	3.03		
		tan δ	144	193	233	254	257	244	210	----	128		
Nylon 610[d]	25	ϵ'/ϵ_o	3.60	3.50	3.35	3.24	3.14	3.05	3.0	----	2.84	----	2.73
		tan δ	155	186	208	221	218	205	200	----	117	----	105
	84	ϵ'/ϵ_o	13.5	11.2	9.0	6.3	4.4	3.7	3.4	----	2.94		
		tan δ	2350	1400	1580	2030	1720	1150	670	----	356		
Nylon 610[d]-90% humidity	25	ϵ'/ϵ_o	4.5	4.2	4.0	3.7	3.2	3.05	3.0	----	2.85		
		tan δ	650	640	600	500	380	280	220	----	125		
Nylon FM 10001[d]	25	ϵ'/ϵ_o	3.84	3.76	3.64	3.49	3.36	3.24	3.17	3.06*	3.02	3.02	
		tan δ	115	180	262	275	232	214	175	140*	120	107	
Resin #90S[e]	25	ϵ'/ϵ_o	3.25	2.94	2.80	2.72	2.64	2.61	2.58		2.54	2.53	
		tan δ	1070	500	274	165	114	92	83		62	57	
h. Cellulose Derivatives													
1) Acetates													
LL-1[f]	25	ϵ'/ϵ_o	3.82	3.77	3.67	3.53	3.42	3.30	3.29	3.28	3.24	3.24	3.1
		tan δ	95	150	200	230	230	210	210	220	290	400	310
	85	ϵ'/ϵ_o	3.98	3.96	3.90	3.77	3.58	3.44	----	----	3.30		
		tan δ	34	75	135	210	270	280	----	----	290		

a. Cellulose (Am. Cyanamid). b. α-cellulose (Libbey-Owens-Ford). c. 28% α paper (Am. Cyanamid). d. Hexamethylene-adipamide (Dupont).
e. Code RC-2072 (General Mills). f. 55.4% acetyl (Hercules).
* Freq. = 1×10^9.

I. Solids, B. Organic, 3. Plastics (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

h. Cellulose Derivatives (cont.)

1) Acetates (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Lumarith XFA-H4[a]	25	ϵ'/ϵ_o	4.61	4.51	4.36	4.13	3.79	3.57	3.37	3.20*	3.13	3.08	
		tan δ	152	240	340	428	480	423	380	365*	340	325	
Fibestos 2050TVA C-1686[b]	26	ϵ'/ϵ_o	4.75	4.53	4.30	3.82	3.60	3.52	3.35				
		tan δ	180	305	380	425	430	400	350				
Tenite I 008A H_2[c]	26	ϵ'/ϵ_o	4.65	4.55	4.40	4.20	3.96	3.72	3.47	-----	3.16	------	3.08
		tan δ	102	173	286	370	430	465	410	-----	310	------	350
Tenite I 008A H_4[c]	26	ϵ'/ϵ_o	4.55	4.48	4.33	4.14	3.90	3.63	3.40	-----	3.25	3.16	3.11
		tan δ	80	175	270	345	393	405	380	-----	310	300	300
Tenite I 008A M[c]	26	ϵ'/ϵ_o	4.97	4.86	4.70	4.52	4.25	3.88	3.57	-----	3.24		
		tan δ	123	175	285	400	495	560	550	-----	380		
Tenite I 008A MH[c]	26	ϵ'/ϵ_o	4.87	4.80	4.60	4.40	4.18	3.80	3.5	-----	3.26	3.09	
		tan δ	117	170	290	380	465	525	550	-----	370	330	
Tenite I 008A S[c]	26	ϵ'/ϵ_o	5.14	5.06	4.90	4.64	4.30	3.96	3.65	-----	3.23		
		tan δ	100	160	280	405	530	620	580	-----	420		
Tenite I 008A S_4[c]	26	ϵ'/ϵ_o	5.34	5.28	5.15	4.90	4.57	4.20	3.75	-----	3.20	------	3.1
		tan δ	85	135	230	370	540	690	700	-----	480	------	380
Tenite II 205A H_2[d]	26	ϵ'/ϵ_o	3.54	3.50	3.44	3.38	3.28	3.18	3.05	-----	2.80		
		tan δ	78	107	158	174	178	180	190	-----	267		
Tenite II 205A H_4[d]	25	ϵ'/ϵ_o	3.54	3.48	3.42	3.37	3.30	3.18	3.08	3.00	2.91	2.82	
		tan δ	50	97	156	175	178	175	170	179	280	298	
Tenite II 205A MH[d]	27	ϵ'/ϵ_o	3.60	3.56	3.50	3.40	3.30	3.22	3.10	-----	2.87	------	
		tan δ	80	117	170	192	200	200	200	-----	310	------	
Tenite II 205A MS[d]	27	ϵ'/ϵ_o	3.67	3.64	3.55	3.45	3.40	3.28	3.15	-----	2.92	2.83	
		tan δ	23	115	178	213	220	227	250	-----	370	360	
Tenite II 205A S_2[d]	27	ϵ'/ϵ_o	3.80	3.75	3.66	3.58	3.48	3.38	3.20	-----	2.98		
		tan δ	82	95	155	204	225	247	300	-----	460		
Tenite II 205A S_4[d]	27	ϵ'/ϵ_o	3.83	3.80	3.74	3.66	3.58	3.44	3.30	-----	3.08	------	2.8
		tan δ	80	90	150	200	235	260	320	-----	520	------	360

a. 28% plast. (Celanese). b. 26% plasticizer (Monsanto). c. 23-31% plasticizer, pigments, dyes (Tenn. Eastman). d. 5-15% plasticizer pigments, dyes (Tenn. Eastman).

* Freq. = 1 x 10^9.

I. Solids, B. Organic 3. Plastics (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

h. Cellulose Derivatives (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$1x10^9$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
2) Propionate													
Forticel[a]	25	ϵ'/ϵ_o	3.52	3.48	3.41	3.33	3.23	3.18	3.08	2.95	2.88	2.87	
		tan δ	60	101	157	188	175	164	192	247	289	308	
3) Nitrate													
Pyralin[b]	27	ϵ'/ϵ_o	10.8	8.4	7.5	7.0	6.6	6.1	5.2	----	3.74	3.32	
		tan δ	6400	1000	450	400	640	930	1030	----	1650	1310	
	78	ϵ'/ϵ_o	----	7.5	6.7	6.3	6.2	6.1	5.2	----	4.0		
		tan δ	----	7000	1500	600	640	930	1030	----	1620		
4) Methyl Cellulose													
Methocel[c]	22	ϵ'/ϵ_o	7.6	6.8	6.4	6.1	5.7	4.9	4.3	----	3.35		
		tan δ	1280	570	330	400	650	1020	1000	----	550		
5) Ethyl Cellulose													
Ethocel LT5[c]	25	ϵ'/ϵ_o	3.11	3.09	3.05	3.02	3.01	2.96	2.90	2.77	2.74	2.70	
		tan δ	75	65	63	76	113	150	160	170	210	250	
Lumarith #22361[d]	24	ϵ'/ϵ_o	3.10	3.06	3.02	2.99	2.92	2.87	2.80	----	2.74	2.67	2.65
		tan δ	48	48	52	67	115	158	160	----	196	256	300
	84	ϵ'/ϵ_o	3.00	3.00	2.90	2.85	2.80	2.80	2.80	----	2.79	2.66	
		tan δ	78	70	66	66	90	140	200	----	214	402	
i. Silicone Resins													
Formica G7[e]	25	ϵ'/ϵ_o	3.73	3.73	3.73	3.73	3.73	3.73	3.73				
(field ⊥ laminate)		tan δ	17	16	15	14	12	15	19				
(field ∥ laminate)	25	ϵ'/ϵ_o	5.18	4.72	4.37	4.09	3.99	3.95	3.94	3.92	3.90	3.90	
		tan δ	790	575	570	530	97	25	22	40	55	45	
Formica G6[e]	25	ϵ'/ϵ_o	3.99	3.91	3.87	3.85	3.82	3.82	3.82	3.81	3.79	3.74	
(field ∥ laminate)		tan δ	210	110	96	130	46	22	27	37	51	61	
(field ⊥ laminate)	25	ϵ'/ϵ_o	3.79	3.79	3.79	3.79	3.79	3.79					
		tan δ	13	11.5	10.5	10	10.5	13.3					

a. 8% plast. (Celanese). b. 25% camphor (DuPont). c. Dow. d. 13% plast. (Celanese). e. Fiberglas laminate (Formica).

I. Solids, B. Organic 3. Plastics (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

1. Silicone Resins (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$1x10^9$	$3x10^9$	$1x10^{10}$
DC 996 cured 16 hrs.	25	ϵ'/ϵ_o	3.08	3.04	3.02	3.01	2.99	2.98	2.96			
at 150°C[a]		tan δ	83	74	65	52	42	38	31			
DC 996 cured 16 hrs.	25	ϵ'/ϵ_o	2.90	2.90	2.90	2.90	2.90	2.90	2.90			
at 250°C[a]		tan δ	14	15	16.5	17.5	18	17	16.5			
DC 2101[b]	24	ϵ'/ϵ_o	2.90	2.90	2.90	2.90	2.90	2.90	2.90			
(discontinued)		tan δ	70	56	49	46	45	45	45			
Polyglas S[c]	24	ϵ'/ϵ_o	3.60	3.59	3.58	3.57	3.57	3.56	----	----	3.55	3.53
		tan δ	11	11	12	13	15	19	----	----	40	46
	80	ϵ'/ϵ_o	3.60	3.59	3.58	3.57	3.57	3.56	----	----	3.55	3.51
		tan δ	27	17	11	10	10	14	----	----	46	49
Molding Compound XM-3[d]	25	ϵ'/ϵ_o	4.03	4.00	3.99	3.98	3.95	3.93	3.92	----	3.85	3.85
		tan δ	51	52	50	47	38	42	50	----	67	94
Dilecto (Silicone glass	25	ϵ'/ϵ_o	3.83	3.82	3.81	3.80	3.80	3.79	3.79			
laminate) GB-261S (field ⊥		tan δ	12.8	13	13	12.3	12.9	14.8	23.5			
sheet)[e]	90	ϵ'/ϵ_o	3.74	3.73	3.71	3.69	3.63	3.56				
		tan δ	21	20	8.5	21	39	26				
	200	ϵ'/ϵ_o	3.50	3.62	3.44	3.42	3.40	3.35				
		tan δ	339	74.7	32.6	22.7	31.4	30				
(field ‖ sheet)	25	ϵ'/ϵ_o	4.97	4.48	4.43	3.95	3.92	3.87	3.87	3.82	3.79	3.76
		tan δ	580	560	440	185	55	29	23	42	57	78
	220	ϵ'/ϵ_o	4.68	4.26	4.18	4.18	----	----	----	----	----	3.87**
		tan δ	1620	526	300	195	----	----	----	----	----	75**
	25*	ϵ'/ϵ_o	4.05	3.93	3.90	3.85						
		tan δ	104	60	42	31						

a. Methyl, phenyl, and methyl phenyl polysiloxane resin (Dow Corning). b. Cross-linked organo-siloxane polymer (Dow Corning). c. 16% DC 2101, 84% Corning's 790 glass powder (Lab. Ins. Res.). d. 35% methyl and phenyl polysilicone resin, 45% glass fibers, 19% silica filler (Dow Corning). e. 50% DC-2103, 50% staple fibre glass base (Cont. Diamond).

*After temperature run. ** 200°C.

I. Solids B. Organic 3. Plastics (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

i. Silicone Resins (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$1x10^9$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Dilecto (silicone glass	25	ϵ'/ϵ_o	3.56	3.56	3.56	3.55	3.54	3.54	3.54				
laminate) GB 112S[a]		tan δ	13.5	12.9	12.9	11.1	8.5	11.4	18.6				
(field ⊥ sheet)	90	ϵ'/ϵ_o	3.41	3.39	3.38	3.38	3.38	3.38					
		tan δ	26.4	16.2	14.9	16.1	11	9.8					
	200	ϵ'/ϵ_o	3.18	3.18	3.18	3.17	3.15	3.10					
		tan δ	236	43	23	195	21	15.4					
(field ∥ sheet)	25	ϵ'/ϵ_o	6.55	5.72	4.94	3.96	3.84	3.82	3.80	3.78	3.76	3.70	
		tan δ	1250	910	1080	516	128	37	25	39	52	87	
	215	ϵ'/ϵ_o	10.93	8.60	6.65	4.92	----	----	----	----	----	3.78	
		tan δ	2000	2080	1800	1410	----	----	----	----	----	80	
	25*	ϵ'/ϵ_o	5.71	5.16	4.54	3.98							
		tan δ	624	880	940	640							
DC 2103 Laminate (XL-48)[b]	25	ϵ'/ϵ_o	3.94	3.92	3.90	3.90	3.90	3.90	3.88	----	3.88**	3.89**	
		tan δ	18	16	15	14	16	26	37	----	67**	99**	
Taylor Grade GSC[c]	25	ϵ'/ϵ_o	5.07	4.14	4.11	4.04	4.03	4.01	----	3.91	3.90	3.85	
(field ∥ laminate)		tan δ	99	72	83	44	20	15	----	30	39	40	
(field ⊥ laminate)	25	ϵ'/ϵ_o	3.78	3.77	3.77	3.77	3.77	3.74	3.74				
		tan δ	13.4	12.5	11	9.5	9.3	11.9	18				
Taylor Grade GSS[d]	25	ϵ'/ϵ_o	4.10	4.00	3.94	3.94	3.94	3.94	3.94	3.92	3.92	3.75	
(field ∥ laminate)		tan δ	160	160	100	34	21	20	30	44	55	63	
(field ⊥ laminate)	25	ϵ'/ϵ_o	3.74	3.74	3.74	3.74	3.74	3.74	3.74				
		tan δ	15	14	13	12	13	15	22				
DC 2104 Laminate (XL-269)[e]	25	ϵ'/ϵ_o	4.14	4.14	4.13	4.13	4.13	4.11	4.10	----	4.07**	4.06**	
		tan δ	32	29	26	22	22	29	34	----	71**	83**	
j. Polyvinyl Resins 1) Polyethylene													
Polyethylene DE-3401[f]	25	ϵ'/ϵ_o	2.26	2.26	2.26	2.26	2.26	2.26	----	----	2.26	2.26	
		tan δ	< 2	< 2	< 2	< 2	< 2	< 2	----	----	3.1	3.6	
Polythene A-3305[g]	24	ϵ'/ϵ_o	2.25	2.25	2.25	2.25	2.25	2.25	----	----	2.25	2.25	2.24
(Now replaced by		tan δ	5	< 3	< 3	< 5	< 4	< 3	----	----	3	4	6.7
Alathon)	80	ϵ'/ϵ_o	2.25	2.25	2.25	2.25	2.25	2.25	----	----	2.25	2.20	
		tan δ	< 5	< 3	< 3	< 5	< 4	< 3	----	----	7.2	8.5	

a. 50% DC-2103, 50% continuous-filament glass base (Cont. Diamond). b. 45% methyl and phenyl polysiloxane resin, 55% ECC-261 Fiberglas (Dow-Corning). c. 45-50% DC-2103, 50-55% cont.-filament glass cloth (Taylor). d. 45-50% DC-2103, 50-55% staple fibre glass cloth (Taylor). e. 35% methyl and phenyl polysiloxane resin, 65% ECC-181 fiberglas (Dow-Corning). f. 0.1% antioxidant (Bakelite). g. 100% polyethylene (DuPont).

*Measured after temperature run. **field ∥ laminate, at other frequencies field ⊥ sheet.

I. Sclids, B. Organic 3. Plastics j. Polyvinyl Resins (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

	$T^{o}C$		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
1) Polyethylene (cont.)													
Polyethylene[a]													
milled 3', 125°C	23	ϵ'/ϵ_o	2.25	2.25	2.25	2.25	2.25	2.25	2.25	----	2.25	2.24	
		tan δ	< 2	< 2	< 2	< 2	< 2	< 2	< 2	----	5.8	6.6	
milled 30', 125°C	23	ϵ'/ϵ_o	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.25	2.25	
		tan δ	< 5	5	6	7	8	9	10	10.6	11.7	11.9	
milled 30', 190°C	-12	ϵ'/ϵ_o	2.38	2.37	2.36	2.35	2.35	2.34	2.33	----	2.32	2.30	
		tan δ	24	21	19	18	21	28	39	----	36	22	
	23	ϵ'/ϵ_o	2.38	2.37	2.36	2.36	2.35	2.34	2.33	2.33	2.32	2.31	
		tan δ	28	28	27	27	28	30	42	51	50	44	
2) Polyisobutylene													
Polyisobutylene[b]	25	ϵ'/ϵ_o	2.23	2.23	2.23	2.23	2.23	2.23	2.23	----	2.23		
Run 5047-2		tan δ	4	1	1	< 2	1	1	3	----	4.7		
Copolene B[c]	25	ϵ'/ϵ_o	2.3	2.3	2.3	2.3	2.3	2.3	2.3	----	2.3		
		tan δ	16	8	4	1	1	7	14	----	11		
3) Polyvinyl chloride-acetate													
Vinylite QYNA[d]	20	ϵ'/ϵ_o	3.18	3.10	3.02	2.96	2.88	2.87	2.85	----	2.84		
		tan δ	130	185	225	210	160	115	81	----	55		
	47	ϵ'/ϵ_o	3.60	3.52	3.41	3.28	3.14	3.02	2.92	----	2.81		
		tan δ	100	166	240	261	228	162	110	----	77		
	76	ϵ'/ϵ_o	3.92	3.83	3.68	3.3	3.0	2.87	2.8	2.8			
		tan δ	180	220	320	400	350	270	190	175			
	96	ϵ'/ϵ_o	6.60	5.30	4.40	3.7	3.3	2.8	2.7	2.7	----	2.6	
		tan δ	1500	1400	1200	980	740	500	320	280	----	180	
	110	ϵ'/ϵ_o	9.9	8.6	6.8	5.6							
		tan δ	1030	1330	1780	1900							
Vinylite VG-5544[e]	25	ϵ'/ϵ_o	7.72	7.20	6.40	5.25	4.13	3.45	3.05	2.99	2.94	2.82	2.80
		tan δ	570	640	1060	1500	1550	1200	650	460	185	159	150
Vinylite VG-5901, black[f]	25	ϵ'/ϵ_o	6.5	5.5	4.6	3.9	3.4	3.1	3.0	2.94	2.88	2.83	
		tan δ	1020	1180	1190	1000	740	500	280	200	106	105	

a. Bakelite. b. 100% Esso Lab.). c. 61% polyisobutylene B-100, 39% Marbon B (Am. Phenolic). d. 100% polyvinyl chloride (Bakelite). e. 40% polyvinyl chloride-acetate, 40% plast., 14% misc. (Bakelite). f. 62.5% polyvinyl chloride-acetate, 29% plast., 8.5% misc. (Bakelite).

I. Solids, B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

3) Polyvinyl chloride

(cont.)	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Vinylite VG-5904, black[a]	25	ϵ'/ϵ_o	8.1	7.5	6.6	5.4	4.3	3.7	3.3	3.1	2.94	2.83	
		tan δ	550	710	1060	1390	1400	1100	670	500	340	320	
Vinylite VU-1900, clear[b]	24	ϵ'/ϵ_o	6.55	5.65	4.70	3.90	3.30	2.95	2.80	----	2.65	2.62	2.62
		tan δ	1000	1150	1300	1180	880	560	310	----	131	104	110
	79	ϵ'/ϵ_o	10.3	8.15	7.5	6.5	5.5	4.3	3.4	----	2.84	2.60	
		tan δ	7300	1250	720	800	1550	2700	1550	----	498	351	
Vinylite VYHH[c]	22	ϵ'/ϵ_o	3.20	3.12	3.06	3.00	2.91	2.88	2.83	----	2.79		
		tan δ	100	130	155	150	140	110	90	----	76		
	47	ϵ'/ϵ_o	3.56	3.48	3.38	3.27	3.16	3.02	2.9	----	2.79		
		tan δ	110	142	190	227	206	152	114	----	92		
Vinylite VYNS[d]	20	ϵ'/ϵ_o	3.10	3.08	3.02	2.95	2.90	2.85	2.8	----	2.74		
		tan δ	115	140	170	170	140	105	80	----	63		
Vinylite VYNW[e]	20	ϵ'/ϵ_o	3.20	3.15	3.05	2.96	2.90	2.84	2.8	----	2.74		
		tan δ	135	165	197	190	150	110	80	----	59		
Geon 2046[f]	23	ϵ'/ϵ_o	6.95	6.10	5.05	4.13	3.55	3.15	3.00	2.97	2.89	2.83	
		tan δ	820	1100	1320	1200	890	570	300	211	116	116	
	80	ϵ'/ϵ_o	9.1	8.8	8.3	7.6	6.5	5.0	4.0	----	3.06	2.90	
		tan δ	250	300	410	680	1540	2800	1500	----	484	328	
Geon 80365[g]	25	ϵ'/ϵ_o	3.67	3.65	3.58	3.52	3.42	3.39	3.34				
		tan δ	68	95	133	145	130	115	120				
Geon 80384[h]	25	ϵ'/ϵ_o	3.43	3.34	3.23	3.14	3.05	3.96	3.95				
		tan δ	120	184	224	217	158	114	101				

a. 54% polyvinyl chloride-acetate, 41% plast., 5% misc. (Bakelite). b. 64.5% polymer of 95% vinyl chloride and 5% vinyl acetate, 32% Flexol D.O.P., 3.5% misc. (Bakelite). c. Polymer of 87% vinyl chloride and 13% vinyl acetate (Bakelite). d. Polymer of 91% vinyl chloride and 9% vinyl acetate (Bakelite). e. Polymer of 95% vinyl chloride and 5% vinyl acetate (Bakelite). f. 59% polyvinyl chloride, 30% dioctyl phosphate, 6% stabilizer, 5% filler (Goodrich). g. 71% polyvinyl chloride, 10.5% filler, 5% plasticizer, 8.5% stabilizer (Goodrich). h. 87.8% polyvinyl chloride, 10.5% stabilizer (Goodrich).

I. Solids B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

3) Polyvinyl Chloride (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Koroseal 5CS-243[a]	27	ϵ'/ϵ_o	6.1	5.65	5.00	4.15	3.60	3.20	2.9	----	2.73	2.62
		tan δ	790	1000	1300	1250	930	560	300	----	112	120
Lucoflex[b]	25	ϵ'/ϵ_o	----	----	----	----	----	----	2.75			
		tan δ	----	----	----	----	----	----	170			
Polyvinyl chloride 1006[c]	25	ϵ'/ϵ_o	6.1	----	4.55	----	3.3					
		tan δ	760	----	1100	----	760					
Polyvinyl chloride 1018[d]	25	ϵ'/ϵ_o	6.2	----	4.95	----	3.15					
		tan δ	630	---	950	----	920					
Polyvinyl chloride 1216[e]	25	ϵ'/ϵ_o	6.1	----	4.4	----	3.2					
		tan δ	1170	----	1110	----	450					
Polyvinyl chloride 1406[f]	25	ϵ'/ϵ_o	6.05	----	4.5	----	3.6					
		tan δ	870	----	940	----	480					
Ultron Wire Compound UL300[g]	25	ϵ'/ϵ_o	3.31	3.22	3.10	2.98	2.85					
		tan δ	150	210	250	220	155					
Ultron Wire Compound UL1004[h]	25	ϵ'/ϵ_o	6.4	----	4.65	----	3.3					
		tan δ	810	----	1210	----	740					
Ultron Wire Compound UL2 4001[k]	25	ϵ'/ϵ_o	6.7	----	4.7	----	3.5					
		tan δ	1100	----	1210	----	700					
Polyvinyl chloride W-174[m]	25	ϵ'/ϵ_o	5.45	4.77	4.17	3.75	3.52	3.25	3.00			
		tan δ	815	930	880	740	550	425	415			
Polyvinyl chloride W-175[n]	25	ϵ'/ϵ_o	5.94	5.20	4.51	3.90	3.44	3.37	3.04			
		tan δ	840	960	960	865	580	430	300			
Polyvinyl chloride W-176[p]	25	ϵ'/ϵ_o	6.21	5.52	4.70	3.96	3.53	3.28	3.00			
		tan δ	730	940	1070	960	720	520	500			

a. 63.7% polyvinyl chloride, 33.1% di-2-ethylhexylphthalate, lead silicate (Goodrich). b. Unplasticized polyvinyl chloride (Lucoflex Plastic). c. 57.5% polymer, 12.6% fillers, 28.7% plasticizers (Monsanto). d. 52.4% polymer, 15.1% fillers, 31.4% plasticizers (Monsanto). e. 57.5% polymer, 10.4% fillers, 31.6% plasticizers (Monsanto). f. 59.4% polymer, 10.7% fillers, 29.7% plasticizers (Monsanto). g. 100% polymer (Monsanto). h. 64.7% polymer, 2% filler, 32.5% plasticizers (Monsanto). k. 60.1% polymer, 7.8% fillers, 31.2% plasticizers (Monsanto). m. 65% Geon 101, 35% Paraplex G-25 (Rohm and Haas). n. 65% Geon 101, 35% Paraplex G-50 (Rohm and Haas). p. 65% Geon, 35% Paraplex G-60 (Rohm and Haas).

I. Solids B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
3) Polyvinyl Chloride (cont.)													
Plasticell[a]	25	ϵ'/ϵ_o	1.04	1.04	1.04	1.04	1.04	----	1.04	1.04*	1.04	1.04	
		tan δ	21	11	< 15	< 15	10	----	10	18*	55	50	
Ensolite M22240[b]	25	ϵ'/ϵ_o	1.51	1.36	1.29	1.24	1.16						
		tan δ	3200	610	330	340	420						
Ensolite M22239[b]	25	ϵ'/ϵ_o	1.48	1.40	1.31	1.25	1.20						
		tan δ	2850	770	280	250	340						
Ensolite 3036[b]	25	ϵ'/ϵ_o	1.30	1.24	1.19	1.17	1.16						
(field ⊥ plane of sample)		tan δ	368	263	187	137	111						
(field ‖ plane of sample)	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	1.14*	1.12	1.10	
		tan δ	----	----	----	----	----	----	----	87*	86	30	
4) Polyvinylidene and Vinyl chloride													
Saran B-115[c]	23	ϵ'/ϵ_o	4.88	4.65	4.17	3.60	3.18	2.97	2.82	----	2.71	2.70	
		tan δ	450	630	885	845	570	310	180	----	72	51	
	84	ϵ'/ϵ_o	5.13	4.94	4.85	4.71	4.40	3.75	3.2	----	2.76		
		tan δ	800	210	130	320	780	1300	900	----	242		
5) Polychlorotrifluoro-ethylene													
Kel-F[d]	26	ϵ'/ϵ_o	2.72	2.63	2.53	2.46	2.43	2.35	----	2.30	2.30	2.29	2.29
		tan δ	210	270	230	135	82	60	----	30	28	39	55
Kel-F Grade 300[d]	25	ϵ'/ϵ_o	2.82	2.76	2.65	2.50	2.46	2.42	2.36	2.35	2.34	2.33	
		tan δ	148	225	212	140	96	75	54	51	66	59	
Kel-F Grade 300-P25[e]	25	ϵ'/ϵ_o	2.84	2.75	2.68	2.58	2.51	2.45	2.37	2.35	2.31	2.26	
		tan δ	126	207	234	204	175	214	186	150	93	93	
6) Polytetrafluoro-ethylene													
Dilecto (Teflon Laminate GB-112T)[f]	25	ϵ'/ϵ_o	2.76	2.74	2.74	2.74	2.73	2.73	2.73				
		tan δ	8.9	6.1	6	6	5.8	6.2	11.8				
(field ⊥ laminate)	250	ϵ'/ϵ_o	2.48	2.46	2.46	2.46	----	2.44					
		tan δ	80	36	18	14	----	2.5					
	25**	ϵ'/ϵ_o	2.70	2.68	2.69	2.69							
		tan δ	4.7	3.9	4.7	4.8							

a. Expanded polyvinyl chloride (Sponge Rubber). b. Modified polyvinyl chloride (U. S. Rubber). c. Polyvinylidene and vinyl chlorides (Dow). d. Polychlorotrifluoroethylene (Kellogg). e. Plasticized polychlorotrifluoroethylene (Kellogg). f. 65-68% Teflon, 32-35% continuous-filament glass base (Cont. Diamond).

I.. Solids, B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

6) Polytetrafluoroethylene (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Dilecto (Teflon Laminate	25	ϵ'/ϵ_o	3.35	3.24	3.18	3.17	3.16	3.15	3.15	3.15**	3.15	3.10	
GB-112T)[a]		tan δ	361	245	169	108	42	23	24	31**	38	47	
(field ∥ laminate)	250	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	3.10	
		tan δ	----	----	----	----	----	----	----	----	----	70	
	25*	ϵ'/ϵ_o	3.26	3.25	3.24	3.21							
		tan δ	66	14.3	17.3	27							
Teflon[b]	22	ϵ'/ϵ_o	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.08	2.08
		tan δ	< 5	< 3	< 3	< 3	< 2	< 2	< 2	1.5	1.5	3.7	6
	100	ϵ'/ϵ_o	2.04	2.04	2.04	2.04	2.04	2.04	----	----	----	2.04	
		tan δ	10	4	2	< 3	< 2	< 2	----	----	----	5.1	
Chemelac M1405[c]	25	ϵ'/ϵ_o	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50		
		tan δ	18	5.1	2.7	3	5	7.2	9	8	6.8		
Chemelac M1406[d]	25	ϵ'/ϵ_o	----	----	----	170	72	----	----	----	12.7		
		tan δ***	----	----	>10000	2400	62	----	----	----	.33		
		ρ	----	520	520	440	410	----	----	----	145		
Chemelac M1407[e]	25	ϵ'/ϵ_o	3.42	3.02	2.85	2.74	2.71	2.65	2.63				
		tan δ	917	700	350	180	150	147	158				
Chemelac M1411[f]	25	ϵ'/ϵ_o	2.14	2.14	2.14	2.14	2.14	2.14	2.14				
(field ⊥ sheet)		tan δ	18.5	9.6	7	6.8	7	9.2	10				
(field ∥ sheet)	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	2.52	2.50	
		tan δ	----	----	----	----	----	----	----	----	25	28	
Chemelac M1412[g]	25	ϵ'/ϵ_o	----	2.35	----	----	----	----	----	----	2.35		
		tan δ	----	12	----	----	----	----	----	----	15		
Chemelac M1414[h]	25	ϵ'/ϵ_o	----	----	----	----	----	150	43	----	33		
		tan δ***	----	----	>10000	>1000	>100	11.8	4.8	----	3.9		
		ρ	----	----	95	95	95	95	80	----	4.8		

a. 65-68% Teflon, 32-35% continuous-filament glass base (Cont. Diamond). b. Polytetrafluoroethylene (DuPont). c. 75% Teflon, 25% calcium fluoride (U.S.Gasket). d. 80% Teflon, 20% carbon (U.S. Gasket). e. 88% Teflon, 12% ceramic (U.S.Gasket). f. 75% Teflon, 25% Fiberglas (U.S.Gasket). g. 75% Teflon, 25% glass (U.S.Gasket). h. 75% Teflon, 25% graphite (U.S.Gasket).

*After temperature run. **Freq. = 1 x10^9. ***tan δ not multiplied by 10^4.

I. Solids, B. Organic 3. Plastics j. Polyvinyl resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

Material	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
6) Polytetrafluoro-ethylene (cont.)													
Chemelac M1418-2[a]	25	ϵ'/ϵ_o	2.30	2.20	2.20	2.15	2.15	2.14	2.14				
(desiccated 48 hrs. P_2O_5)		tan δ	600	200	45	4	2	2.5	5				
(dried in oven)	25	ϵ'/ϵ_o	2.	2.15	2.15	2.15	2.15						
		tan δ	11	6	2.7	1.5	1.8						
Chemelac M1418-5[b]	25	ϵ'/ϵ_o	2.27	2.23	2.18	2.18	2.16	2.16	2.16				
		tan δ	450	118	32	8.8	5.7	5.9	7.1				
Chemelac M1422[c]	25	ϵ'/ϵ_o	2.72	2.72	2.72	2.72	2.72	2.72	2.72				
		tan δ	11.9	7.7	4.5	2.8	2.0	1.8	2.4				
Chemelac M1423[d]	25	ϵ'/ϵ_o	----	1.308	----	----	----	----	----	----	----	1.30	
		tan δ	----	1.81	----	----	----	----	----	----	----	62	
7) Polyvinyl alcohol-acetate													
Elvanol 51A-05[e]	25	ϵ'/ϵ_o	8.2	7.8	7.2	6.2	5.2	4.5	----	----	3.74	3.50	3.46
		tan δ	430	440	580	720	900	1000	----	----	550	502	620
	85	ϵ'/ϵ_o	400	100	33	16	10	7.3	----	----	4.67		
		tan δ	15000	13000	9000	3600	2300	2000	----	----	1770		
Elvanol 50A-42[f]	23	ϵ'/ϵ_o	14.0	10.4	8.0	6.6	5.7	5.0	----	----	3.75		
		tan δ	4050	1850	1150	1000	950	900	----	----	715		
	68	ϵ'/ϵ_o	85	26	14	9.5	7.5	5.8					
		tan δ	9600	8100	4000	1600	1400	1500					
	100	ϵ'/ϵ_o	3000	400	50	18	13	8.7	----	----	5.6	4.1	
		tan δ	15000	22000	20000	4800	2700	2600	----	----	2300	3000	
Elvanol 70A-05[f]	26	ϵ'/ϵ_o	----	----	58	27	14	7	----	----	4.12		
		tan δ	----	----	8200	5900	4100	2700	----	----	840		
Elvanol 72A-51[f]	26	ϵ'/ϵ_o	----	----	45.5	22.0	12.5	7.5	----	----	3.89	3.8	3.8
		tan δ	----	----	7600	5100	3500	2500	----	----	640	636	730
Elvacet 42A-900[g]	25	ϵ'/ϵ_o	3.09	3.07	3.05	3.02	2.98	2.94	2.90	----	2.88		
		tan δ	49	50	52	56	65	49	37	----	28		
	85	ϵ'/ϵ_o	7.3	7.15	5.9	3.75	3.25	2.95	2.90	----	2.87		
		tan δ	180	590	2400	1830	830	560	200	----	85		

a. 90% Teflon, 10% quartz (U.S.Gasket). b. 75% Teflon, 25% quartz (U.S.Gasket). c. 80% Teflon, 20% titanium dioxide (U.S.Gasket). d. Air-filled Teflon (U.S.Gasket). e. Polyvinyl alcohol-acetate, 11-14% acetoxyl (DuPont). f. Polyvinyl alcohol-acetate, 0-1.5% acetoxyl (DuPont). g. Polyvinyl acetate (DuPont).

I. Solids, B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

8) Polyvinyl acetals	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Formvar, Type E[a]	26	ϵ'/ϵ_o	3.16	3.12	3.08	3.00	2.92	2.85	-----	-----	2.76	------	2.7
		tan δ	54	100	154	190	190	165	-----	-----	113	------	115
	88	ϵ'/ϵ_o	3.55	3.5	3.4	3.25	3.1	2.95	2.85	-----	2.80		
		tan δ	60	83	102	145	213	310	300	-----	227		
Alvar 11/90[b]	25	ϵ'/ϵ_o	3.17	3.14	3.09	3.03	2.96	2.90	2.82	2.80	2.73	2.70	2.65
		tan δ	65	70	100	140	180	160	125	119	136	175	175
	84	ϵ'/ϵ_o	3.84	3.54	3.40	3.25	3.05	2.90	-----	-----	2.74		
		tan δ	575	390	270	195	180	225	-----	-----	196		
Butvar, Low OH[c]	27	ϵ'/ϵ_o	2.69	2.67	2.65	2.63	2.61	2.59	----	----	2.51	2.48	2.46
		tan δ	38	40	56	88	124	138	----	----	111	107	99
Butvar 55/98[c]	27	ϵ'/ϵ_o	3.04	3.02	2.98	2.94	2.86	2.75	2.67	-----	2.62		
		tan δ	41	59	108	161	215	216	177	-----	172		
9) Polyacrylates													
Lucite HM-119[d]	-12	ϵ'/ϵ_o	3.0	2.9	2.8	2.7	2.63	2.60	2.59	-----	2.58	2.57	
(now replaced by HM-140)		tan δ	330	250	190	140	102	70	55	-----	35.4	34	
	23	ϵ'/ϵ_o	3.20	2.84	2.75	2.68	2.63	2.60	2.58	-----	2.58	2.57	2.57
		tan δ	620	440	315	220	145	100	67	-----	51.3	49	32
	81	ϵ'/ϵ_o	3.97	3.45	3.08	2.86	2.72	2.62	2.59	-----	2.58	2.57	
		tan δ	600	820	720	540	380	220	130	-----	77	95	
Lucite, sintered[e]	27	ϵ'/ϵ_o	2.29	2.12	2.01	2.00	2.00	2.00	2.00	-----	1.82		
(obsolete)		tan δ	408	290	195	116	66	49	40	-----	52		
Gafite cast polymer[f]	25	ϵ'/ϵ_o	3.25	3.12	3.02	2.97	2.90	2.88	2.83				
(sheet sample)		tan δ	310	240	183	155	115	77	64				
(rod sample)	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	2.75	2.75	2.75	
		tan δ	----	----	----	----	----	120	----	99	78	83	
Plexiglas[g]	27	ϵ'/ϵ_o	3.40	3.12	2.95	2.84	2.76	2.71	-----	2.66	2.60	2.59	
		tan δ	605	465	300	200	140	100	-----	62	57	67	
	80	ϵ'/ϵ_o	4.30	3.80	3.34	3.00	2.80	2.70	-----	-----	2.56		
		tan δ	700	895	800	520	320	210	-----	-----	79		

a. Polyvinyl formal (Shawinigan). b. Polyvinyl acetal (Shawinigan). c. Polyvinyl butyral (Shawinigan). d. Polymethyl methacrylate (DuPont). e. DuPont. f. Methyl and alpha-chloroacrylate (Gen. Aniline). g. Polymethyl methacrylate (Rohm and Haas).

I. Solids, B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

9) Polyacrylates (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Polyethyl methacrylate[a]	22	ϵ'/ϵ_o	2.90	2.75	2.65	2.60	2.55	2.53	------	------	2.51	2.50	2.5
		tan δ	420	294	185	118	90	75	------	------	75	97	83
	80	ϵ'/ϵ_o	3.87	3.36	2.86	2.70	2.61	2.57	2.55	------	2.49	2.48	
		tan δ	810	1060	960	710	400	260	140	------	91	135	
Polybutyl methacrylate[a]	-12	ϵ'/ϵ_o	2.50	2.46	2.44	2.42	2.41	2.40	------	------	2.38		
		tan δ	190	120	68	42	33	25	------	------	48		
	24	ϵ'/ϵ_o	2.82	2.62	2.52	2.47	2.43	2.42	------	------	2.38	2.36	
		tan δ	605	360	200	125	80	55	------	------	44	46	
	81	ϵ'/ϵ_o	3.70	3.52	3.14	2.82	2.60	2.48	------	------	2.39		
		tan δ	150	650	1200	980	470	220	------	------	185		
Polyisobutyl methacrylate[a]	25	ϵ'/ϵ_o	2.70	2.68	2.63	2.55	2.45	2.45	2.42	2.40	2.39	2.38	2.37
		tan δ	111	70	50	37	35	46	52	47	31	39	52
	80	ϵ'/ϵ_o	2.9	2.7	2.5	2.5	2.44	2.42	2.42	2.40	2.39	2.38	
		tan δ	830	600	360	210	100	80	70	65	54	59	
Polycyclohexyl methacrylate[b]	25	ϵ'/ϵ_o	2.58	2.52	2.52	2.52	2.52	2.48	2.47	-----	2.46	-----	2.46
		tan δ	46	47.5	60	50	28	23	25	-----	34.9	-----	41
	84	ϵ'/ϵ_o	2.63	2.60	2.55	2.47	2.42	2.39	2.37	------	2.37		
		tan δ	150	124	98	81	68	38	32	------	49		
10) Polystyrene													
Polystyrene[c] (commercially molded)													
Sheet Stock	25	ϵ'/ϵ_o	2.56	2.56	2.56	2.56	2.56	2.56	2.55	2.55	2.55	2.54	2.54
		tan δ	< 0.5	< 0.5	< 0.5	0.5	0.7	< 2	< 1	3.5	3.3	4.3	12
	80	ϵ'/ϵ_o	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.53	
		tan δ	9	2	< 1	< 2	< 2	< 2	< 3	2.7	4.5	5.3	
Rod Stock											2.5	3.6	4.8
Sample A	25	tan δ	------	------	------	------	------	------	------	------	12	------	22
Sample B	25	tan δ	------	------	------	------	------	------	------	------	16		
Sample B	80	tan δ	------	------	------	------	------	------	------	------			

a. DuPont. b. Polaroid. c. For sheet stock, various samples used for different frequencies; for rod stock, ϵ'/ϵ_o is the same as for sheet stock (Plax).

I. Solids. B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

10) Polystyrene (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Styron C-176[a]	25	ϵ'/ϵ_o	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.54	2.54	2.54
		tan δ	< 3	< 2	< 2	< 2	< 2	< 2	< 3	1.7	2.3	3.0	5.3
	80	ϵ'/ϵ_o	2.55	-----	-----	-----	-----	-----	-----	-----	2.5	2.5	
		tan δ	12	-----	-----	-----	-----	-----	-----	-----	5.0	6.5	
Styron C-176,	25	ϵ'/ϵ_o	-----	-----	-----	-----	-----	-----	-----	-----	2.54		
30% humidity[b]		tan δ	-----	-----	-----	-----	-----	-----	-----	-----	3.2		
Styron C-176,	25	ϵ'/ϵ_o	-----	-----	-----	-----	-----	-----	-----	-----	2.54		
50% humidity[b]		tan δ	-----	-----	-----	-----	-----	-----	-----	-----	4.9		
Styron C-176,	25	ϵ'/ϵ_o	-----	-----	-----	-----	-----	-----	-----	-----	2.54	2.54	
90% humidity[b]		tan δ	-----	-----	-----	-----	-----	-----	-----	-----	7.7	7.3	
Styron C-176 + 0.5%	25	ϵ'/ϵ_o	-----	-----	-----	-----	-----	-----	-----	-----	2.54		
paraffin, 90% humidity[b]		tan δ	-----	-----	-----	-----	-----	-----	-----	-----	2.5		
Styron 411-A[c] (formerly	22	ϵ'/ϵ_o	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.54	2.54	2.54
Exp. Plastic Q-247)		tan δ	< 3	< 2	< 2	< 2	< 2	< 2	< 3	2.1	3.1	3.7	5.3
	79	ϵ'/ϵ_o	2.55	2.55	2.55	2.55	2.55	2.55	2.55	-----	2.54	2.54	
		tan δ	12	2.5	< 2	< 2	< 2	2	3	-----	5.2	6	
Styron 475[b]	25	ϵ'/ϵ_o	2.62	2.61	2.59	2.56	2.56	2.55	2.55	2.53*	2.53	2.53	
		tan δ	3.6	3.0	2.4	2.6	4.2	7.6	11	19*	36	17	
Styron 666[b]	25	ϵ'/ϵ_o	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54*	2.53	2.52	
		tan δ	1.75	1.1	< 1	< 1	.7	1.2	2	2.7*	3.1	3.4	
Styron 671[b]	25	ϵ'/ϵ_o	2.55	2.55	2.55	2.55	2.54	2.54	2.54	2.54*	2.54	2.54	
		tan δ	.97	.64	< .5	< .5	.2	.38	.57	1.47*	1.76	2.1	

a. Polystyrene (Dow). Similar values given by Dow's C-244 and Q-247.1; Catalin's Loalin #1 Color 4000; Bakelite's XMS-4A-621, XRS-23-B10012-44, XRS-23-B10012-52Q, XRS-23-B10016-D63, XRS-23-B10012-D107; Monsanto's Samples D-277, D-279 (extra purity), D-334.

b. Polystyrene (Dow). c. Polystyrene (Dow). Similar values given by Monsanto's Lustron Res. Sample D-276.

*Freq. = 1×10^9.

I. Solids, B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

10) Polystyrene (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Fibers Q-107[a]	26	ϵ'/ϵ_o	2.14	2.14	2.14	2.14	2.14	2.14	2.14	-----	2.11		
		tan δ	7.6	6.3	4.6	3	3	3	4	-----	6.3		
Foam Q-103, 90% humidity[a]	27	ϵ'/ϵ_o	-----	-----	-----	-----	-----	-----	-----	-----	1.03		
		tan δ	-----	-----	-----	-----	-----	-----	-----	-----	<0.3		
Styrofoam 103.7[b]	25	ϵ'/ϵ_o	1.03	1.03	1.03	1.03	1.03	1.03	-----	-----	1.03	1.03	
		tan δ	< 2	< 1	< 1	< 1	< 2	< 2	-----	-----	1	1.5	
Polystyrene cast in vacuo[c]	25	ϵ'/ϵ_o	2.55	2.55	2.55	2.55	2.55	2.55	-----	-----	2.55		
		tan δ	1	1	0.5	< 2	< 2	< 3	-----	-----	2.4		
Polystyrene cast in air[c]	25	ϵ'/ϵ_o	-----	2.50	2.50	2.50	2.50	2.50	-----	-----	2.48		
		tan δ	-----	9	5.5	< 5	2	8	-----	-----	12.8		
Experimental Plastic Q764.6[a]	25	ϵ'/ϵ_o	2.63	2.58	2.58	2.58	2.58	2.58	2.58	2.55*	2.51	2.51	
		tan δ	2.5	1.3	1.8	2.5	2.3	1.4	2.8	7.3*	8.2	6.5	
Experimental Plastic Q767.2[a]	25	ϵ'/ϵ_o	2.98	2.95	2.92	2.90	2.86	2.83	2.80	2.77*	2.75	2.75	
		tan δ	62	73	80	74	65	55	43	36*	38	43	
Styramic #18[d]	22	ϵ'/ϵ_o	2.68	2.66	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.63	2.63
		tan δ	29	18.4	5	< 2	< 2	< 2	1.6	1.9	2.2	2.3	4
	78	ϵ'/ϵ_o	2.7	2.7	2.67	2.65	2.65	2.65	2.65	----	2.63		
		tan δ	91	67	25	6.5	4	4	3	----	2.0		
11) Misc. Polystyrenes													
Exp. Plastic Q817.1[e]	25	ϵ'/ϵ_o	2.60	2.60	2.60	----	2.59	2.58	2.57	2.57*	2.57	2.56	
		tan δ	.7	.6	.61	----	.7	1	2.1	4.8*	4.5	3	
Exp. Plastic Q406[f]	25	ϵ'/ϵ_o	2.60	2.59	2.58	2.57	2.56	2.55	2.52	2.50*	2.49	2.49	
		tan δ	7.3	6.2	4.7	3.6	2.2	1.5	1.2	1.9*	2.0	2.6	
Poly-p-xylylene[g]	25	ϵ'/ϵ_o	2.45	2.45	2.45	2.45	2.45	2.45	----	----	2.45		
		tan δ	2	3.4	3.9	< 2	0.7	3.7	----	----	9		

a. Dow. b. 99.75% polystyrene, 0.25% filler (Dow). c. From Dow's N-100 styrene (Lab. Ins. Res.). d. 50% polystyrene, 50% chlorinated diphenyl (Monsanto). e. Poly alpha-methylstyrene (Dow). f. Polyvinyltoluene (Dow). g. Pressed fibers (Polaroid).
*Freq. = 1×10^9.

I. Solids, B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

12) Styrene copolymers

linear	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Styrene-2,4-dimethyl-	25	ϵ'/ϵ_o	2.53	2.53	2.53	2.53	2.52	2.52	2.52	2.51*	2.50	2.49	
styrene copolymer[a]		tan δ	1.6	1.3	0.8	0.7	0.9	1.2	1.5	4.0*	5.4	2.8	
Styrene-acrylonitrile	25	ϵ'/ϵ_o	2.96	2.95	2.92	2.87	2.80	2.78	2.77	2.77*	2.77	2.76	
copolymer[a]		tan δ	59	63	67	67	64	50	41	40*	41	45	
Darex copolymer 3[b]	25	ϵ'/ϵ_o	2.53	2.53	2.52	2.51	2.50	2.49	2.49	----	2.48	2.45	
		tan δ	23.7	21.5	30.9	38.9	34.8	26.8	23.8	----	21.3	20.9	
Darex copolymer 43E[b]	25	ϵ'/ϵ_o	2.54	2.54	2.54	2.54	2.54	2.54	2.54	----	2.54	2.53	
		tan δ	5.5	2.8	2.2	2.8	3.9	6.2	8.2	----	9.8	13	
Darex copolymer X-34[b]	25	ϵ'/ϵ_o	2.55	2.54	2.54	2.53	2.52	2.52	2.51	----	2.50	2.48	
		tan δ	20.4	12.7	17.5	19.5	12	15	14	----	11.6	12	
Darex copolymer X-43[b]	25	ϵ'/ϵ_o	2.56	2.56	2.56	2.56	2.55	2.55	2.55	----	2.55	2.54	
		tan δ	7.3	2.5	2.3	2.2	3	4	5.5	----	8.9	11.6	
Styraloy 22[c]	-12	ϵ'/ϵ_o	2.4	2.4	2.4	2.4	2.4	2.4	----	----	2.4	2.4	
		tan δ	8	8	4	15	36	52	----	----	28	18	
	23	ϵ'/ϵ_o	2.4	2.4	2.4	2.4	2.4	2.4	2.40	2.40	2.4	2.4	2.4
		tan δ	9	6	5	7	12	30	52	46	32	24	18
	81	ϵ'/ϵ_o	2.4	2.4	2.4	2.4	2.4	2.4	----	----	2.4	2.4	
		tan δ	16	10	8	6	6	13	----	----	51	55	
Marbon S[d]	25	ϵ'/ϵ_o	2.62	2.62	2.62	2.61	2.60	2.60	2.57	2.55*	2.55	2.54	
Code 7206		tan δ	17.4	14.1	13.8	13.8	18.3	22.1	22.2	20.6*	20	19	
Marbon S-1	25	ϵ'/ϵ_o	2.55	2.55	2.54	2.54	2.54	2.54	2.53	2.52*	2.52	2.52	
Code 7254[d]		tan δ	10	6	3.5	3.9	6.1	7.9	8.3	10*	11	12.5	
Marbon 8000[e]	25	ϵ'/ϵ_o	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.52*	2.51	2.51	
		tan δ	5.4	4	3.2	3.0	4.0	5.0	7.2	9.0*	9.7	10	
Marbon 9200[f]	25	ϵ'/ϵ_o	2.60	2.57	2.56	2.56	2.56	2.56	2.55	2.52*	2.52	2.52	
		tan δ	5.4	3.1	3	4.9	6.7	9	10	11.8*	11.9	11.5	

a. Am. Cyanamid. b. Dewey and Almy. c. Copolymer of butadiene and styrene (Dow). d. Butadiene-styrene copolymer, ca. 10% butadiene (Marbon). e. Butadiene-styrene copolymer ca. 15% butadiene (Marbon). f. Butadiene-styrene copolymer ca. 14% butadiene (Marbon).

*Freq. = 1 x 10^9.

I. Solids, B. Organic 3. Plastics J. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$1x10^9$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
12) Styrene copolymers, linear (cont.)													
Piccolastic D-125[a]	25	ϵ'/ϵ_o	2.58	2.58	2.58	2.58	2.58	2.58	2.58	----	2.55	2.52	
		tan δ	2	1.5	1	1	1	1.5	3	----	5	5	
Styrene (50%) and 1,3,5-trivinyl-2,4,6-trichlorobenzene (50%) copolymer[b]	25	ϵ'/ϵ_o	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.66	2.65	2.65	
		tan δ	8.5	8.9	9.7	10	11	16.2	26	20	21	19	
Styrene (50%) and 1,4-divinyl-2,3,5,6-tetrachlorobenzene (50%) copolymer[b]	26	ϵ'/ϵ_o	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70	
		tan δ	6	7.4	8.2	7.8	8.2	12.0	22	13.2	13.8	13.6	
S-40[c]	25	ϵ'/ϵ_o	2.40	2.40	2.40	2.39	2.39	2.39	2.38	----	2.37	2.35	
		tan δ	21	14	13	12	8	6	6	----	6.4	7.1	
S-60[c]	25	ϵ'/ϵ_o	2.50	2.49	2.48	2.46	2.46	2.45	2.45	----	2.44	2.44	
		tan δ	27	24	20	15	10	6	4	----	6.5	7.4	
13) Styrene copolymers cross-linked													
Copolymer 8012[d]	25	ϵ'/ϵ_o	2.58	2.58	2.58	2.58	2.58	2.57	2.55	2.54	2.53	2.52	
		tan δ	2.7	1.3	.87	.7	1.1	2	3.8	6.8	8.8	8.9	
Plastic EK2784[d]	25	ϵ'/ϵ_o	2.59	2.59	2.59	2.56	2.56	2.56	2.56	2.55	2.54	2.52	
		tan δ	2.6	1.5	1.2	1.4	1.8	2.3	4.2	8.8	6.7	4.7	
Exp. Plastic Q-166[e]	23	ϵ'/ϵ_o	3.44	3.40	3.38	3.36	3.32	3.22	3.05	----	2.71	2.62	
		tan δ	45	55	70	110	180	350	420	----	315	250	
	80	ϵ'/ϵ_o	3.25	3.23	3.21	3.19	3.16	3.12	3.05	----	2.85	2.63	
		tan δ	550	95	41	38	55	110	250	----	570	550	
Exp. Plastic Q-166[e] plus Fiberglas	23	ϵ'/ϵ_o	4.46	4.42	4.37	4.30	4.21	4.09	3.95	----	3.78	3.70	3.6
		tan δ	160	110	96	120	180	250	320	----	241	231	200
	79	ϵ'/ϵ_o	4.5	4.4	4.4	4.3	4.2	4.1	4.0	----	3.8	3.7	
		tan δ	880	320	140	85	80	130	220	----	415	470	
Exp. Plastic Q-200.5[f]	26	ϵ'/ϵ_o	2.55	2.55	2.55	2.55	2.55	2.55	2.55	----	2.55	----	2.54
		tan δ	4	< 2	< 2	< 2	2	3.4	4	----	5.2	----	24
	100	ϵ'/ϵ_o	2.56	2.56	2.56	2.56	2.55	2.55	----	----	2.55*		
		tan δ	20	7	2	< 2	< 2	< 3	----	----	7.6*		

a. Methylstyrene-styrene copolymer (Penn. Ind. Chem.). b. Sprague (two different castings measured in the ranges 10^2 - 10^8 and 10^9 - 10^{10} c/s.) c. Standard Oil Dev. Co. N.J. d. Catalin. e. Dow. f. Cross-linked with o-, m-, p-divinylbenzenes (Dow).

*Measurements made at 78°C.

I. Solids, B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

13) Styrene copolymers cross-linked (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Exp. Plastic Q-344[a]	24	ϵ'/ϵ_o	2.40	2.40	2.39	2.38	2.38	2.38	2.38	----	2.34	2.31	2.31
		tan δ	11	20	50	20	9	7	7	----	9	8.6	10
	80	ϵ'/ϵ_o	2.4	2.4	2.39	2.38	2.38	2.38	2.35	----	2.33	2.31	
		tan δ	21	14	12	16	45	42	19	----	19	15	
Exp. Plastic Q-475.5[a]	22	ϵ'/ϵ_o	2.51	2.51	2.51	2.51	2.51	2.51	2.51	----	2.50	2.49	
		tan δ	4	2	2	4	7	9	9	----	6.3	8	
	80	ϵ'/ϵ_o	2.48	2.48	2.48	2.48	2.48	2.48	2.48	----	2.47	2.47	
		tan δ	6	4	2	2	4	9	14	----	16	14	
Pliolite S5[b]	25	ϵ'/ϵ_o	2.58	2.58	2.58	2.55	2.55	2.55	2.55	2.53*	2.51	2.51	
		tan δ	6.8	3.3	2.1	2.5	4.7	7.3	7.8	7.6*	7.2	6.7	
Pliolite S3[b]	25	ϵ'/ϵ_o	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.55*	2.52	2.52	
		tan δ	7.7	3.5	2.1	1.8	2.6	3.6	6.2	15*	8.8	7.5	
Pliolite S6B[b]	25	ϵ'/ϵ_o	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.53*	2.52	2.51	
		tan δ	6	2.9	2.4	1.9	2	3.7	6.8	10.6*	11	8	
Pliolite S6[b]	25	ϵ'/ϵ_o	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.57	2.52	2.52	
		tan δ	6.6	2.8	2.1	2.1	2.1	3	5.5	16	7.6	6.3	
Resin C[c]	25	ϵ'/ϵ_o	2.51	2.51	2.51	2.51	2.50	2.50	2.47	----	2.47	2.46	
		tan δ	8	10	13	27	34	31	29	----	30	39	
Rexolite 1422[d]	25	ϵ'/ϵ_o	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55*	2.54	2.54	
		tan δ	2.1	1.1	1	1.1	1.3	2	3.8	4.6*	4.8	4.7	
Bureau of Standards	25	ϵ'/ϵ_o	2.64	2.62	2.62	2.62	2.62	2.62	2.62	2.60	2.59		
Casting Resin[e]		tan δ	20	15.6	11	7	4.7	9	11	11	5		
Vibron 140[f]	25	ϵ'/ϵ_o	2.59	2.59	2.59	2.58	2.58	2.58	2.58	----	2.58	2.57	
		tan δ	4	5	8	12	16	19	20	----	19	17.5	
Vibron 141[f]	23	ϵ'/ϵ_o	2.64	2.64	2.64	2.63	2.62	2.62	2.62	----	2.62	2.62	
		tan δ	6	7	11	19	33	39	34	----	28	28	

a. Cross-linked polystyrene (Dow). b. Goodyear. c. Esso C oil in styrene-divinylbenzene solution (Polarcid). d. Rex Corp.
e. 32.5% polystyrene, 53.5% poly-2,5-dichlorostyrene, 13% hydrogenated terphenyl, 0.5% divinylbenzene (U.S. Bur. Stand.).
f. U. S. Rubber.
*Freq. = $1x10^9$.

I. Solids B. Organic 3. Plastics J. Polyvinyl resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

14) Polystyrene plus fillers	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Polystyrene 91%,	26	ϵ'/ϵ_o	3.85	3.85	3.85	3.85	3.85	3.84	----	3.81	3.60	3.46	
carbon 9%[a]		tan δ	17	24	30	33	32	37	----	310	386	344	
Polystyrene 70%,	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	11*	9.1	8.8	
carbon 30%[a]		tan δ	----	----	----	----	----	----	----	2300*	2500	1100	
Polystyrene 50%,	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	25.9*	20.8	19.4	
carbon 50%[a] (molded at 1000 p.s.i.)		tan δ	----	----	----	----	----	----	----	7300*	5600	2800	
(molded at 10000 p.s.i.)	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	36*	25	24	
		tan δ	----	----	----	----	----	----	----	4600*	6200	3000	
Lustrex Loaded Glass Mat[b]	25	ϵ'/ϵ_o	3.04	3.04	3.02	3.00	2.97	2.97	2.96				
(field ⊥ plane of laminate)		tan δ	13.8	8.8	7.4	7	8.3	10.6	13.8				
(field in plane of laminate)	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	3.07	3.07	
		tan δ	----	----	----	----	----	----	----	----	31	36	
Polyglas P+ (experimental)[c]	24	ϵ'/ϵ_o	3.36	3.36	3.36	3.36	3.36	3.36	----	----	3.35	3.33	3.32
		tan δ	8	7	7	7	7	7	----	----	7.8	8.4	14.0
	79	ϵ'/ϵ_o	3.36	3.36	3.36	3.36	3.36	3.36	----	----	3.35	3.33	
		tan δ	30	17	12	9	8	7	----	----	14	19	
Polyglas P+ (technical)[d]	25	ϵ'/ϵ_o	3.38	3.38	3.38	3.38	3.38	3.38	----	3.36	3.35	3.34	
		tan δ	9	9	9	9	9	9	----	9.6	11.7	19	
15) Polychlorostyrenes													
Plastic CY-8[e]	24	ϵ'/ϵ_o	2.61	2.61	2.60	2.60	2.60	2.60	2.6	----	2.60	----	2.59
		tan δ	< 2	< 2	< 2	< 2	< 2	2	2.5	----	3.1	----	29
	80	ϵ'/ϵ_o	2.61	2.61	2.60	2.60	2.60	2.60	2.6	----	2.60		
		tan δ	6	2	< 3	< 3	< 3	3	4	----	7.3		
Plastic CQ-10DM[f]	25	ϵ'/ϵ_o	2.70	2.70	2.70	2.70	2.70	2.70	2.69	2.67	2.66		
		tan δ	5	5	5	6	8	10	11	11	10.8		
	100	ϵ'/ϵ_o	2.66	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65		
		tan δ	33	17	8	6	7	11	16	17	17		

a. Cabot's #9 (Lab. Ins. Res.). b. 30% fiberglas (Monsanto). c. 18.6% Dow's C-244 polystyrene, 81.1% Corning's 790 glass powder, 0.25% paraffin, 0.1% Dow Corning's Ignition Sealing Compound No. 4 (Lab. Ins. Res.). d. Id. except that Monsanto's polystyrene was used (Monsanto). e. 97% poly-2,5-dichlorostyrene (Mathieson). f. Copolymer of 50% 2,4,-25% 2,5-, 25% 2,3-, 2,6- and 3,4-dichlorostyrenes (Mathieson).

*Freq. = $1x10^9$.

I. Solids B. Organic 3. Plastics i. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

15) Polychlorostyrenes (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Poly-3, 4-dichloro-	25	ϵ'/ϵ_o	2.94	2.93	2.91	2.88	2.85	2.80	2.77	----	2.72	2.70	
styrene[a]		tan δ	85	70	57	50	42	35	27	----	20	20	
	82	ϵ'/ϵ_o	3.0	2.90	2.85	2.83	2.78	2.73	2.68	----	2.65		
		tan δ	203	157	115	77	63	60	55	----	32		
	103	ϵ'/ϵ_o	3.08	2.92	2.85	2.81	2.8	2.8	2.75	----	2.7	2.7	
		tan δ	355	275	200	120	82	78	70	----	60	60	
	153	ϵ'/ϵ_o	6.0	4.9	3.7	3.3							
		tan δ	850	1700	1400	750							
Exp. Plastic Q-409[b]	24	ϵ'/ϵ_o	2.60	2.60	2.60	2.60	2.60	2.60	2.60	----	2.60	2.60	2.60
		tan δ	10	7	5	5	4	4	5	----	8.7	12	16
	90	ϵ'/ϵ_o	2.69	2.69	2.68	2.68	2.68	2.67	2.65	----	2.64	2.60	
		tan δ	50	25	14	8	5.5	5.5	7	----	11	18	
Polyglas D+(experimental)[c]	24	ϵ'/ϵ_o	3.22	3.22	3.22	3.22	3.22	3.22	3.22	----	3.22	3.22	
		tan δ	7	6	5	5	6	6	7	----	8	8.5	
	79	ϵ'/ϵ_o	3.2	3.2	3.2	3.2	3.2	3.2	3.2	----	3.2	3.2	
		tan δ	34	17	11	8	7	7	8	----	13	16	
Polyglas D+(technical)[d]	24	ϵ'/ϵ_o	3.25	3.25	3.25	3.25	3.25	3.25	3.24	----	3.23	3.22	3.22
		tan δ	3	3	4	4	5	6	7	----	12	13	14
16) Poly-2,5-dichloro-styrene plus fillers													
Poly-2,5-dichlorostyrene	23	ϵ'/ϵ_o	5.30	5.30	5.30	5.30	5.30	5.30	5.30	----	5.30	5.30	
(58.1%), TiO_2 (41.9%)[e]		tan δ	26	14	8	5	3	3	3	----	6	8.5	
Poly-2,5-dichlorostyrene	24	ϵ'/ϵ_o	10.2	10.2	10.2	10.2	10.2	10.2	10.2	----	10.2	10.2	
(34.7%), TiO_2 (65.3%)[e]		tan δ	16	8	6	4	3	3	3	----	7.5	13	
Poly-2,5-dichlorostyrene	23	ϵ'/ϵ_o	23.6	23.4	23.2	23.1	23.0	23.0	23.0	----	----	23.0	
(18.6%), TiO_2 (81.4%)[e]		tan δ	60	41	30	20	12	9	8	----	----	15.6	

a. ca. 95% (Monsanto). b. Copolymer of o- and p-chlorostyrenes (Dow). c. 34.9% Monsanto's poly-2,5-dichlorostyrene; 64.9% Corning's 790 glass powder, 0.1% paraffin wax, 0.1% Dow Corning's Ignition Sealing Compound No. 4 (Lab. Ins. Res.). d. Id. (Monsanto).
e. Monsanto's Styramic HT; Titanium Alloy's Tam Ticon T, heavy grade (Lab. Ins. Res.).

I. Solids B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

16) Poly-2,5-dichlorostyrene plus fillers (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Poly-2,5-dichlorostyrene	23	ϵ'/ϵ_o	6.10	6.10	6.10	6.09	6.09	6.08	6.05	6.01	5.91	
(38.2%), $MgTiO_3$ (61.8%)[a]		tan δ	35	22	14	10	7	6	6	7	8.9	
Poly-2,5-dichlorostyrene	25	ϵ'/ϵ_o	5.20	5.20	5.20	5.19	5.18	5.17	5.15	----	4.97	4.90
(63.0%), $SrTiO_3$ (37.0%)[b]		tan δ	20	10	6	4	3	4	5	----	11.7	14.1
Poly-2,5-dichlorostyrene	24	ϵ'/ϵ_o	9.65	9.65	9.63	9.62	9.61	9.60	9.57	----	----	9.36
(40.5%), $SrTiO_3$ (59.5%)[b]		tan δ	41	37	16	12	10	9	10	----	----	23
Poly-2,5-dichlorostyrene	23	ϵ'/ϵ_o	17.9	17.4	17.4	17.3	17.3	17.2	17.0	----	----	15.2
(25.2%), $SrTiO_3$ (74.8%)[b]		tan δ	220	130	78	42	30	22	23	----	----	64
Poly-2,5-dichlorostyrene	23	ϵ'/ϵ_o	24.5	22.8	21.6	21.2	21.2	21.0	20.8	----	----	19.5
(14.4%), $SrTiO_3$ (80.6%)[b]		tan δ	780	380	180	100	60	40	33	----	----	50
Poly-2,5-dichlorostyrene	23	ϵ'/ϵ_o	4.10	4.08	4.07	4.06	4.04	4.03	4.03	----	4.02	4.02
(66.6%), $BaTiO_3$ (33.4%)[c]		tan δ	24	14	8	6	4	3	3	----	17	38
Poly-2,5-dichlorostyrene	25	ϵ'/ϵ_o	9.7	9.7	9.7	9.7	9.7	9.7	9.7	----	----	9.7
(32.8%), $BaTiO_3$ (67.2%)[c]		tan δ	60	42	25	14	7	6	6	----	----	143
Poly-2,5-dichlorostyrene	23	ϵ'/ϵ_o	15.8	15.8	15.8	15.8	15.7	15.7	15.7	----	----	15.5
(23.5%), $BaTiO_3$ (76.5%)[c]		tan δ	30	30	25	12	7	7	13	----	----	214
Poly-2,5-dichlorostyrene	23	ϵ'/ϵ_o	19.4	19.3	19.1	18.9	18.9	18.9	18.9	----	----	18.4
(21.0%), $BaTiO_3$ (79.0%)[c]		tan δ	52	35	25	16	11	7	8	----	----	314
Poly-2,5-dichlorostyrene (94%), Fe (6%)[d]	25	μ'/μ_o	----	----	----	----	----	----	----	----	1.02	.98
		tan δ_m	----	----	----	----	----	----	----	----	250	270
		ϵ'/ϵ_o	----	----	----	----	----	----	----	----	2.78	2.78
		tan δ_d	----	----	----	----	----	----	----	----	7	15
	83	μ'/μ_o	----	----	----	----	----	----	----	----	1.04	
		tan δ_m	----	----	----	----	----	----	----	----	300	
		ϵ'/ϵ_o	----	----	----	----	----	----	----	----	2.7	
		tan δ_d	----	----	----	----	----	----	----	----	40	

a. Monsanto's Styramic HT; Titanium Alloy's Tam Ticon MC (Lab. Ins. Res.). b. Monsanto's Styramic HT; Titanium Alloy's Tam Ticon S (Lab. Ins. Res.). c. Monsanto's Styramic HT; Titanium Alloy's Tam Ticon B (Lab. Ins. Res.). d. Monsanto's D-1795; Plastic Metals' Plast-Iron, minus 200 mesh, annealed (Lab. Ins. Res.).

I. Solids B. Organic 3. Plastics J. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

16) Poly-2,5-dichlorostyrene plus fillers (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Poly-2,5-dichlorostyrene (60%), Fe (40%)[a]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	5.3	5.2
		μ'/μ_o	----	----	----	----	----	----	----	----	1.16	.96
		tan δ_d	----	----	----	----	----	----	----	----	270	190
		tan δ_m	----	----	----	----	----	----	----	----	2300	2620
	85	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	5.1	
		μ'/μ_o	----	----	----	----	----	----	----	----	1.27	
		tan δ_d	----	----	----	----	----	----	----	----	----	
		tan δ_m	----	----	----	----	----	----	----	----	3000	
Poly-2,5-dichlorostyrene (49.3%), Fe (50.7%)[a]	25	ϵ'/ϵ_o	9.8	9.7	9.5	9.2	9.0	8.7	----	8.08	6.93	
		μ'/μ_o	----	3.00	----	----	----	2.70	----	2.00	1.24	
		tan δ_d	110	130	160	190	220	320	----	601	644	
		tan δ_m	----	----	----	----	----	340	----	2254	3170	
Poly-2,5-dichlorostyrene (40.7%) Fe (59.3%)[a]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	13.8	10	
		μ'/μ_o	----	----	----	----	----	----	----	2.6	1.37	
		tan δ_d	----	----	----	----	----	---	----	1950	1400	
		tan δ_m	----	----	----	----	----	----	----	2810	4500	
Poly-2,5-dichlorostyrene (92%), Fe_3O_4 (8%)[b]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	2.78	2.76	2.64
		μ'/μ_o	----	----	----	----	----	----	----	1.05	1.03	1.03
		tan δ_d	----	----	----	----	----	----	----	13		
		tan δ_m	----	----	----	----	----	----	----	77	200	420
Poly-2,5-dichlorostyrene (83.7%) Fe_3O_4 (16.3%)[b]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	3.2	3.2	3.2
		μ'/μ_o	----	----	----	----	----	----	----	1.12	1.07	.99
		tan δ_d	----	----	----	----	----	----	----	18		
		tan δ_m	----	----	----	----	----	----	----	200	420	580
Poly-2,5-dichlorostyrene (75%) Fe_3O_4 (25%)[b]		ϵ'/ϵ_o	----	----	----	----	----	----	---	3.45	3.44	
		μ'/μ_o	----	----	----	----	----	----	----	1.19	1.12	
		tan δ_d	----	----	----	----	----	----	----	26		
		tan δ_m	----	----	----	----	----	----	----	250	590	

a. Monsanto's D-1795; Plastic Metals' Plast-Iron, minus 200 mesh, annealed (Lab. Ins. Res.). b. Monsanto's D-1795; Mallinckrodt's magnetite (Lab. Ins. Res.).

I. Solids B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

16) Poly-2,5-dichlorostyrene plus fillers (cont.)

	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Poly-2,5-dichlorostyrene	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	4.08	4.07	
(55.9%) Fe_3O_4(34.1%)[a]		μ'/μ_o	----	----	----	----	----	----	----	1.30	1.17	
		tan δ_d	----	----	----	----	----	----	----	42		
		tan δ_m	----	----	----	----	----	----	----	390	1010	
Poly-2,5-dichlorostyrene	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	5.00	4.98	
(56.2%) Fe_3O_4 (43.8%)[a]		μ'/μ_o	----	----	----	----	----	----	----	1.45	1.23	
		tan δ_d	----	----	----	----	----	----	----	75		
		tan δ_m	----	----	----	----	----	----	----	560	1720	
Poly-2,5-dichlorostyrene	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	7.4	7.3	7.3
(46.0%) Fe_3O_4 (54.0%)[a]		μ'/μ_o	----	----	----	----	----	----	----	1.65	1.32	.91
		tan δ_d	----	----	----	----	----	----	----	150		
		tan δ_m	----	----	----	----	----	----	----	780	2400	3500
Poly-2,5-dichlorostyrene	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	9.8	9.5	
(35.7%) Fe_3O_4 (64.3%)[a]		μ'/μ_o	----	----	----	----	----	----	----	1.94	1.41	
		tan δ_d	----	----	----	----	----	----	----	450	180	
		tan δ_m	----	----	----	----	----	----	----	980	3000	
Poly-2,5-dichlorostyrene	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	20	18	
(24.5%) Fe_3O_4 (75.5%)[a]		μ'/μ_o	----	----	----	----	----	----	----	2.38	1.60	
		tan δ_d	----	----	----	----	----	----	----	2000	300	
		tan δ	----	----	----	----	----	----	----	1430	3700	
Poly-2,5-dichlorostyrene	25	ϵ'/ϵ_o	24.8	16.9	11.9	10.0	7.6	5.0	----	3.76		
(38.55%) $(Mn,Fe)_3O_4$ (61.45%)[b]		μ'/μ_o	----	----	----	----	----	----	----	2.56		
		tan δ_d	2500	2500	2400	2300	1900	900				
		tan δ_m	----	----	----	----	----	----	----	4000		
Poly-2,5-dichlorostyrene	25	ϵ'/ϵ_o	----	99	39	29	21	7.4	----	6.9	6.5	
(21.3%) $(Mn,Fe)_3O_4$ (78.7%)[b]		μ'/μ_o	----	----	----	----	----	----	----	4.3	1.32	
		tan δ_d	----	27700	10000	6200	4800	930	----	90	< 50	
		tan δ_m	----	----	----	----	----	----	----	4900	13200	

a. Monsanto's D-1795; Mallinckrodt's magnetite (Lab. Ins. Res.). b. Monsanto's D-1795; iron-manganese oxide (Lab. Ins. Res.).

I. Solids B. Organic 3. Plastics j. Polyvinyl Resins (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
17) Polyvinyl cyclohexane												
Polyvinylcyclohexane[a]	24	ϵ'/ϵ_o	2.25	2.25	2.25	2.25	2.25	2.25	2.25	----	2.25	2.25
		tan δ	15	2	< 2	< 2	< 2	< 2	< 2	----	1.8	3.9
18) Poly-α-vinylnaphthalene												
Poly-α-vinylnaphthalene[b]	24	ϵ'/ϵ_o	----	2.6	2.6	2.6	2.6	2.6	2.6			
		tan δ	----	9.5	6.7	7.5	8.7	13	22			
19) Poly-2-vinylpyridine												
Poly-2-vinylpyridine[b]	22	ϵ'/ϵ_o	4.91	4.64	4.26	3.77	3.56	3.33	3.1	3.06	2.98	
		tan δ	360	460	560	600	560	420	280	240	135	
2-Vinylpyridine-styrene	23	ϵ'/ϵ_o	3.44	3.38	3.26	3.13	3.00	2.90	2.82	----	2.76	
copolymer[b]		tan δ	168	230	270	290	260	185	120	----	65	
20) Poly-N-vinylcarbazole												
Polectron #24[c]	25	ϵ'/ϵ_o	2.95	2.95	2.95	2.95	2.95	2.95	2.95	----	2.88	
		tan δ	13	9	6	5	4	5	6	----	9.3	
	80	ϵ'/ϵ_o	2.95	2.95	2.95	2.95	2.95	2.95				
		tan δ	19	10	8	9	9	7				
k. Polyesters												
Laminac 4115[d]	25	ϵ'/ϵ_o	3.24	3.22	3.20	3.17	3.12	3.07	2.94	2.87*	2.83	2.82
		tan δ	37.5	43.2	68.3	113	135	147	141	107*	93	88
Experimental Resin	25	ϵ'/ϵ_o	4.15	4.05	3.93	3.77	3.58	3.44	3.20	----	3.00	2.95
PDL7-669[d]		tan δ	155	192	247	306	313	282	240	----	155	142
Laminac PDL7-627[d]	25	ϵ'/ϵ_o	3.26	3.25	3.23	3.18	3.08	3.06	3.03	2.96*	2.92	2.86
		tan δ	50.5	42.8	67.8	115	140	148	135	107*	95	91.4
Laminac PDL7-650[d]	25	ϵ'/ϵ_o	3.02	3.00	2.98	2.95	2.89	2.82	2.78	----	2.74	2.72
		tan δ	39.1	45.0	60.2	100	119	114	108	----	92	96
Laminac 4-205[d]	25	ϵ'/ϵ_o	4.45	4.36	4.24	4.03	3.86	3.69	3.49	----	3.21	3.15
		tan δ	147	162	219	301	360	345	340	----	240	243
Formica Z65[e]	25	ϵ'/ϵ_o	5.21	5.10	5.00	4.89	4.70	4.35	----	3.83*	3.69	3.49
(field ∥ laminate)		tan δ	191	162	212	317	434	570	----	485*	445	425
(field ⊥ laminate)	25	ϵ'/ϵ_o	4.77	4.70	4.68	4.60	4.45	4.17				
		tan δ	125	108	131	185	302	418				

a. Hydrogenated polystyrene (Dow). b. Lab. Ins. Res. c. Poly-N-vinylcarbazole, 1.3% HB-40 oil (Gen. Aniline). d. Amer. Cyanamid.
e. 50% Shell's DAP 85/80, 50% paper (Formica).
*Freq. = $1x10^9$.

I. Solids B. Organic 3. Plastics (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

k. Polyesters (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Formica Z80[a]	25	ϵ'/ϵ_o	4.76	4.75	4.72	4.65	4.46	4.08	3.77	3.53*	3.41	3.36
(field ∥ laminate)		tan δ	175	160	210	310	420	565	500	390*	310	250
(field ⊥ laminate)	25	ϵ'/ϵ_o	4.52	4.42	4.38	4.33	4.15	3.91				
		tan δ	95	96	130	197	330	440				
Glastic S[b]	26	ϵ'/ϵ_o	3.50	3.39	3.29	3.22	3.16	3.14	3.07			
		tan δ	330	250	160	98	100	105	130			
Glastic MF[b]	26	ϵ'/ϵ_o	3.92	3.82	3.76	3.72	3.65	3.57	3.53			
		tan δ	270	185	135	125	130	130	135			
Plaskon 911[c]	24	ϵ'/ϵ_o	3.88	3.81	3.75	3.66	3.56	3.42	3.25	3.17	3.07	3.02
		tan δ	89	125	165	210	240	240	220	217	175	158
	80	ϵ'/ϵ_o	4.27	4.17	4.06	3.95	3.83	3.70	3.55	----	3.26	3.10
		tan δ	165	150	155	200	270	320	340	----	299	248
Marco Resin MR-21C[d]	25	ϵ'/ϵ_o	3.37	3.35	3.31	3.25	3.16	3.08	----	2.90	2.84	2.82
		tan δ	53	51	65	102	150	170	----	149	106	123
Marco Resin MR-23C[d]	25	ϵ'/ϵ_o	4.56	4.50	4.40	4.28	4.14	3.88	----	3.24	2.92	2.82
		tan δ	130	140	170	220	340	570	----	810	500	410
Marco Resin MR-25C[d]	25	ϵ'/ϵ_o	3.27	3.24	3.20	3.15	3.10	3.06	2.90	2.86	2.77	2.73
		tan δ	76	72	82	108	138	165	190	185	130	135
Laminating Resin MP,	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	4.26
Glass reinforced[e]		tan δ	----	----	----	----	----	----	----	----	----	110
Laminating Resin MT,	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	4.24
Glass reinforced[f]		tan δ	----	----	----	----	----	----	----	----	----	88
Laminate BD-44[g]	24	ϵ'/ϵ_o	3.32	3.28	3.22	3.19	3.14	3.08	3.02	2.99	2.93	2.91
		tan δ	95	81	85	105	125	140	150	132	109	110

a. 52% Shell's DAP 25/50, 48% yarn fabric (Formica). b. With Fiberglas (Laminated Plastics). c. Unsaturated polyester (Libby-Owens-Ford). d. Unsaturated polyester (Marco). e. Resin of 50% Vibron x-1039 alkyd and 50% triallyl cyanurate plus catalyst and Fiberglas ECC-181-114 (Naugatuck). f. Resin of 45% polyethylene tetraclophthate-maleate alkyd and 55% triallyl cyanurate plus catalyst and Fiberglas ECC-181-114 (Naugatuck). g. Selectron 5003, Fiberglas (Owens-Corning).

*Freq. = $1x10^9$.

I. Solids B. Organic 3. Plastics (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

k. Polyesters (cont.)	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Laminate BK 164[a]	24	ϵ'/ϵ_o	4.12	4.10	4.09	4.07	4.05	4.03	4.00	3.98	3.94	3.90	
		tan δ	67	58	63	80	96	110	112	108	120	130	
Stypol 16B[b]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	2.88	
		tan δ	----	----	----	----	----	----	----	----	----	180	
Stypol 16C[b]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	2.75	
		tan δ	----	----	----	----	----	----	----	----	----	160	
Stypol 16D[b]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	2.81	
		tan δ	----	----	----	----	----	----	----	----	----	140	
Paraplex P13[c]	25	ϵ'/ϵ_o	4.02	4.00	3.92	3.92	3.65	3.32	3.08	2.89*	2.77	2.77	
		tan δ	73	108	184	310	530	590	600	140*	320	290	
Paraplex P43[c]	25	ϵ'/ϵ_o	3.23	3.22	3.19	3.16	3.11	3.04	2.98	2.89*	2.85	2.85	
		tan δ	33	43	68	98	130	160	160	110*	100	80	
Polydiallyl phthalate[d]	26.8	ϵ'/ϵ_o	3.60	3.57	3.50	3.42	3.35	3.24	3.1	----	2.95	2.95	
		tan δ	104	95	118	150	200	241	195	----	118	118	
Allymer CR-39[e]	24	ϵ'/ϵ_o	4.18	4.14	4.03	3.85	3.52	3.27	3.07	----	2.88	----	2.76
		tan δ	90	120	210	380	520	460	330	----	203	----	165
	84	ϵ'/ϵ_o	4.90	4.84	4.70	4.47	4.18	3.85	3.45	----	3.02		
		tan δ	130	140	170	250	440	840	740	----	370		
Allymer CR-39 laminate[f]	25	ϵ'/ϵ_o	4.84	4.80	4.73	4.57	4.37	4.17	3.98	----	3.78		
		tan δ	73	80	120	208	315	295	205	----	140		
Phoresin[g]	25	ϵ'/ϵ_o	3.98	3.84	3.70	3.65	3.49	3.32	3.15	3.10	3.03	3.02	2.96
		tan δ	260	270	320	330	280	210	165	145	171	165	164
m. Alkyd resins													
Chlorinated alkyd	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	----	1.179	
diisocyanate, foamed[h]		tan δ	----	----	----	----	----	----	----	----	----	27	
Alkyd, diisocyanate,	25	ϵ'/ϵ_o	1.223	1.223	1.223	1.223	1.218	1.205	1.20	----	1.20	1.19	
foamed[k]		tan δ	19.8	14.7	22.7	33.5	41	42	38	----	34	22	
Red Glyptal #1201[m]	25	ϵ'/ϵ_o	4.9	4.5	4.1	4.0	3.9	3.8					
		tan δ	760	600	500	400	320	290					

a. 38% polyester (Bakelite BRS-16631), 62% Fiberglas (Owens-Corning). b. Robertson. c. Rohm and Haas. d. Shell Dev. e. Allyl resin (Southern Alkali Corp.) f. 40% resin, 60% ECC-11-148 Fiberglas (Southern Alkali Corp.). g. Diallyl phenyl phosphonate resin (Victor). h. Cornell Aeronautical Labs. k. Goodyear Aircraft. m. General Electric.

*Frequency = $1x10^9$.

I. Solids B. Organic 3. Plastics (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

m. Alkyd resins (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
#51 Permo Potting	25	ϵ'/ϵ_o	3.18	2.95	2.83	2.74	2.70	2.64	2.59	2.55*	2.53	2.52
Compound[a]		tan δ	730	410	260	174	124	101	120	182*	125	122
Glastic Grade GF[b]	25	ϵ'/ϵ_o	----	----	----	----	3.76					
		tan δ	----	----	----	----	95					
Glastic Grade MM[b]	25	ϵ'/ϵ_o	4.17	4.13	4.09	4.02	3.96	3.88	3.78			
		tan δ	102	87	84	99	115	125	136			
Glastic Grade MP[b]	25	ϵ'/ϵ_o	----	----	----	----	3.56					
		tan δ	----	----	----	----	267					
Glastic Grade A-2[b]	25	ϵ'/ϵ_o	----	----	----	----	4.34					
		tan δ	----	----	----	----	518					
Plaskon Alkyd Special Electrical Granular[c]	25	ϵ'/ϵ_o	5.32	5.10	4.96	4.90	4.76	4.65	4.55	4.54*	4.50	4.47
		tan δ	366	236	170	147	149	152	138	121*	108	138
Plaskon Alkyd 411[c]	25	ϵ'/ϵ_o	6.02	5.77	5.60	5.36	5.19	4.95	4.63	----	4.32	4.31
		tan δ	340	240	220	260	310	320	288	----	220	178
Plaskon Alkyd 420[c]	25	ϵ'/ϵ_o	5.50	5.35	5.24	5.10	5.03	4.90	4.82			
		tan δ	270	160	130	147	153	147	145			
Plaskon Alkyd 422[c]	25	ϵ'/ϵ_o	5.47	5.26	5.14	5.01	4.92	4.85	4.77	4.75*	4.75	4.72
		tan δ	365	213	151	134	120	113	110	100*	104	126
Plaskon Alkyd 440[c]	25	ϵ'/ϵ_o	5.13	5.04	4.95	4.85	4.73	4.61	4.50	4.42*	4.38	4.33
		tan δ	191	151	154	185	196	188	172	133*	137	146
Plaskon Alkyd 440A[c]	25	ϵ'/ϵ_o	5.28	5.19	5.10	4.97	4.90	4.78	4.65	4.63*	4.62	4.61
		tan δ	165	133	131	143	146	146	134	124*	141	149
Plaskon Alkyd 442[c]	25	ϵ'/ϵ_o	5.02	4.89	4.80	4.71	4.59	4.50	4.44	4.37*	4.34	4.29
		tan δ	212	189	140	141	146	142	122	127*	131	141
n. Epoxy resins												
Araldite Casting Resin	25	ϵ'/ϵ_o	3.67	3.67	3.67	3.65	3.62	3.49	3.35	3.28	3.09	3.01
Type B[d]		tan δ	17	24	50	110	190	270	340	340	270	220
Araldite E-134[d]	25	ϵ'/ϵ_o	7.3	6.1	5.3	4.7	4.4	4.1	3.7	3.5	3.2	3.1
		tan δ	1200	1050	920	760	770	1000	1300	750	460	390
Araldite Casting	25	ϵ'/ϵ_o	4.05	3.99	3.92	3.81	3.69	3.54	3.39	3.25*	3.15	3.10
Resin G[d]		tan δ	105	104	141	210	270	288	300	311*	310	263

a. Hardman. b. Laminated Plastics. c. Libbey-Owens-Ford. d. Ciba.

I. Solids B. Organic 3. Plastics (cont.) — Values for tan δ are multiplied by 10^4; frequency given in c/s.

n. Epoxy Resins (cont.)	T°C		1x10²	1x10³	1x10⁴	1x10⁵	1x10⁶	1x10⁷	1x10⁸	3x10⁸	3x10⁹	1x10¹⁰	2.5x10¹⁰
Araldit Adhesive	25	ϵ'/ϵ_o	4.00	3.97	3.91	3.82	3.71	3.46	3.27	----	3.14		
Type I Natural[a]		tan δ	29	52	120	200	300	350	340	----	230		
Araldite Adhesive	25	ϵ'/ϵ_o	11.6	11.6	11.5	11.3	11.0	10.5	10.2	9.9	9.6	9.2	
Type I Silver[a]		tan δ	38	62	120	190	300	370	360	360	520	980	
Hysol 6000[b]	25	ϵ'/ϵ_o	3.47	3.43	3.38	3.30	3.26	3.17	3.10	3.07	3.00	2.96	
		tan δ	73	61	70	92	130	170	170	150	120	120	
Hysol 6020[b]	25	ϵ'/ϵ_o	3.96	3.90	3.82	3.67	3.54	3.42	3.29	----	3.01	2.99	
		tan δ	68	113	206	260	272	266	299	----	274	252	
Hysol 6030 flexible	25	ϵ'/ϵ_o	6.65	6.15	5.75	5.37	4.74	4.15	3.61	----	3.20	3.11	
Potting Compound[b]		tan δ	605	485	469	593	840	1010	900	----	380	324	
Hysol 6000 PR[b]	25	ϵ'/ϵ_o	3.85	3.80	3.69	3.64	3.57	3.44	3.33	----	3.18	3.18	
		tan δ	90	99	107	163	227	248	250	----	192	180	
Hy-tuf Laminate Grade	25	ϵ'/ϵ_o	4.67	4.62	4.52	4.45	4.34	4.21	4.15				
GF181[b] (field ⊥ laminate)		tan δ	92	99	125	145	212	239	242				
(field ∥ laminate)	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	4.14*	4.08	4.05	
		tan δ	----	----	----	----	----	----	----	171*	177	180	
Epon Resin RN-48[c]	25	ϵ'/ϵ_o	3.64	3.63	3.61	3.57	3.52	3.44	3.32	3.13*	3.04	2.91	
		tan δ	31	38	68	111	142	191	264	220*	210	184	
o. Miscellaneous Plastics													
E Resin[d]	23	ϵ'/ϵ_o	2.49	2.49	2.48	2.48	2.47	2.45	2.45	----	2.43	2.42	
		tan δ	7	4	< 3	< 5	5	8	8	----	6	5	
	80	ϵ'/ϵ_o	2.5	2.5	2.5	2.5	2.5	2.45	2.45	----	2.4	2.4	
		tan δ	25	14	8	5	4	6	7	----	15	17	
Same material after	25	ϵ'/ϵ_o	2.56	2.56	2.55	2.54	2.54	2.54	2.53	2.5	----	2.44	2.43
3 1/2 yrs. at room temp. and humidity		tan δ	8	11	16	19	21	22	19	16	----	7	11
Permafil 3256[e]	24	ϵ'/ϵ_o	4.27	4.22	4.12	4.01	3.86	3.70	3.5	----	----	3.1	3.0
		tan δ	98	120	170	230	300	330	340	----	----	276	290
	99	ϵ'/ϵ_o	4.95	4.85	4.75	4.61	4.48	4.28	4.05	----	----	3.34	
		tan δ	200	155	160	200	300	440	570	----	----	580	
	125	ϵ'/ϵ_o	5.12	5.04	4.92	4.77	4.62	4.4	4.1	----	----	3.38	
		tan δ	280	180	170	185	260	410	550	----	----	560	
Piccopale Resin[f]	25	ϵ'/ϵ_o	2.33	2.33	2.33	----	2.33	2.33	2.33	----	2.30		
		tan δ	< 3	< 3	< 3	----	< 5	2	8	----	3.5		

a. Ciba. b. Houghton Labs. c. Shell Chem. d. Cross-linked addition hydrocarbon polymer (Esso Lab.). e. Cross-linked addition polymer (Gen. Elec.). f. Linear addition hydrocarbon copolymer made with aliphatic dienes and olefins (Penn. Industrial Chem.).
*Freq. = $1x10^9$.

I. Solids, B. Organic 4. Elastomers

Values for tan δ are multiplied by 10^4; frequency given in c/s.

	$T^{\circ}C$		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
a. Natural Rubber												
Hevea rubber[a]	-12	ϵ'/ϵ_o	2.4	2.4	2.4	2.4	2.4	2.4	2.4			
		tan δ	10	14	24	44	55	38	33			
	25	ϵ'/ϵ_o	2.4	2.4	2.4	2.4	2.4	2.4	2.4	----	2.15	
		tan δ	28	18	14	14	18	32	50	----	30	
	80	ϵ'/ϵ_o	2.4	2.4	2.4	2.4	2.4	2.4	2.4			
		tan δ	132	79	48	27	21	21	30			
Hevea rubber, vulcanized[b]	27	ϵ'/ϵ_o	2.94	2.94	2.93	2.88	2.74	2.52	2.42	----	2.36	
		tan δ	48	24	62	220	446	410	180	----	47	
Hevea rubber compound[c]	27	ϵ'/ϵ_o	4.09	4.01	3.92	3.80	3.64	3.44	3.3	----	3.25	
		tan δ	130	155	182	230	308	405	265	----	148	
Hevea rubber compound[d]	27	ϵ'/ϵ_o	----	36	27	14	9.0	7.0	6.8	----	6.3	
		tan δ	----	25000	12000	4000	2500	1600	850	----	234	
Cellular Rubber[e]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	1.31	1.31
		tan δ	----	----	----	----	----	----	----	----	75	94
#49 Permo Potting Compound[f]	25	ϵ'/ϵ_o	3.46	3.39	3.28	3.18	2.96	2.80	2.72	2.63*	2.60	
		tan δ	169	230	274	320	370	350	215	170*	180	
b. Gutta-percha												
Gutta-percha[g]	25	ϵ'/ϵ_o	2.61	2.60	2.58	2.55	2.53	2.50	2.47	2.45	2.40	2.38
		tan δ	5	4	9	21	42	80	120	110	60	50
c. Balata												
Balata, precipitated[h]	25	ϵ'/ϵ_o	2.50	2.50	2.50	2.50	2.50	2.47	2.42	2.41	2.40	2.39
		tan δ	9	5	4	5	15	33	62	63	37	30
d. Cyclized Rubbers												
Pliolite[i]	27	ϵ'/ϵ_o	2.5	2.5	2.5	2.5	2.5	2.5	2.45	----	2.4	
		tan δ	52	35	31	31	37	46	46	----	31	
Pliolite GR[i]	25	ϵ'/ϵ_o	2.6	2.6	2.6	2.55	2.55	2.55	----	----	----	2.5
		tan δ	92	98	78	60	44	33	----	----	----	33

a. Pale crepe (Rubber Res. Corp.). b. 100 pts. pale crepe, 6 pts. sulfur (Rubber Res. Corp.). c. 100 pts. pale crepe, 1 pt. stearic acid, 10 pts. United Black, 5 pts. Kadox, 0.5 pts, Captax, 3 pts. sulfur (Rubber Res. Corp.). d. 100 pts. pale crepe, 1 pt. stearic acid, 40 pts. United Black, 5 pts. Kadox, 1 pt. Captax, 3 Pts. sulfur (Rubber Res. Corp.). e. Cellular Rubber Prod. f. Depolymerized rubber (Hardman). g. Palaquium Oblongifolium (Hermann Weber). h. Minusops Globosa (Hermann Weber). i. Goodyear.

*Freq. = $1x10^9$.

I. Solids B. Organic 4. Elastomers (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^6$	$3x10^9$	$1x10^{10}$
d. Cyclized Rubbers (cont.)												
Pliobond M-190-C[a]	24	ϵ'/ϵ_o	14	12	9.5	7.9	6.3	4.8	4.0	----	3.76	
		tan δ	7800	1900	850	900	2000	1900	1000	----	740	
e. Buna Rubbers												
Air seal[b]	24	ϵ'/ϵ_o	15.3	8.9	6.2	4.4	3.6	3.3	3.1	3.0	2.8	2.8
		tan δ	5200	3100	2300	1700	990	740	580	410	180	120
GR-S (Buna S) uncured[c]	-12	ϵ'/ϵ_o	----	2.5	2.5	2.5	2.5	2.45				
		tan δ	----	13	24	62	80	50				
	26	ϵ'/ϵ_o	2.5	2.5	2.5	2.5	2.50	2.45	2.45	----	2.45	
		tan δ	6	9	10	18	38	69	71	----	44	
	80	ϵ'/ϵ_o	----	2.5	2.5	2.5	2.50	2.45	2.45			
		tan δ	----	4	4	4	6	22	60			
GR-S (Buna S) compound[d]	26	ϵ'/ϵ_o	2.66	2.66	2.66	2.65	2.56	2.52	2.52	----	2.49	2.44
		tan δ	7	9	25	60	120	160	95	----	56	50
GR-S (Buna S) compound	25	ϵ'/ϵ_o	2.98	2.97	2.95	2.93	2.91	2.88	2.82	----	2.78	2.77
BKG-117-G[e]		tan δ	10	24	54	100	120	128	80	----	57	48
	80	ϵ'/ϵ_o	2.84	2.83	2.82	2.81	2.78	2.76	2.72	2.70	2.69	
		tan δ	86	31	26	33	65	110	120	114	83	
Hycar OR Cell-tite[f]	25	ϵ'/ϵ_o	1.41	1.40	1.39	1.38	1.38	1.38	1.38	----	1.38	1.37
		tan δ	115	58	50	51	56	54	47	----	39	38
Marbon S, Buna S	25	ϵ'/ϵ_o	1.31	1.31	1.31	1.30	1.30	1.30	1.29	----	1.28	1.27
Hardboard[g]		tan δ	14	12	22	36	37	28	19	----	17	16
f. Butyl Rubbers												
GR-I (butyl rubber)[h]	25	ϵ'/ϵ_o	2.39	2.38	2.37	2.36	2.35	2.35	2.35	----	2.35	2.35
		tan δ	34	35	27	13	10	10	10	----	9	8
GR-I compound[i]	25	ϵ'/ϵ_o	2.43	2.42	2.41	2.40	2.40	2.40	2.39	----	2.38	2.38
		tan δ	50	60	58	38	22	15	10	----	9.3	9.9

a. Solution and suspension of thermosetting resins and vulcanizable elastomers (Goodyear). b. Kearney. c. Copolymer of 75% butadiene and 25% styrene (Rubber Res. Corp.). d. 100 pts. GR-S, 1 pt. stearic acid, 5 pts. Kadox, 5 pts. Captax, 3 pts. Sulfur (Rubber Res. Corp.). e. lfur, Selanac, Altax, Methyl Tuads, zinc oxide, Akroflex, Heliozone, Cumar MH, stearic acid, limestone, Marbon S-1, etc. (Gen. Cable). f. Based on butadiene polymer (Sponge Rubber Prod.). g. U.S.Rubber. h. Copolymer of 98-99% isobutylene, 1-2% isoprene (Rubber Res. Corp.). i. 100 pts. GR-I 44-7 M_2K, 5 pts. zinc oxide (from $ZnCO_3$), 1 pt. Tuads, 1.5 pts. sulfur (Rubber Res. Corp.).

I. Solids, B. Organic 4. Elastomers (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

g. Nitrile Rubbers	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Kralastic BE Natural[a]	25	ϵ'/ϵ_o	4.80	4.75	4.70	4.40	4.00	3.30	3.00	2.85*	2.80	2.70	
		tan δ	280	130	180	530	1100	1050	560	240*	180	130	
Kralastic BM Natural[a]	25	ϵ'/ϵ_o	4.48	4.45	4.35	4.20	3.78	3.15	2.91	2.83*	2.76	2.70	
		tan δ	130	96	160	490	990	940	490	220*	160	110	
Kralastic D Natural[a]	25	ϵ'/ϵ_o	3.54	3.54	3.51	3.44	3.20	2.90	2.78	2.68*	2.66	2.62	
		tan δ	105	52	82	260	530	550	270	130*	93	65	
Kralastic EBMU Natural[a]	25	ϵ'/ϵ_o	4.47	4.42	4.36	4.29	4.05	3.38	2.98	2.88*	2.80	2.72	
		tan δ	102	75	102	230	720	1300	760	300*	210	140	
Kralastic F Natural[a]	25	ϵ'/ϵ_o	4.20	4.20	4.15	4.00	3.61	3.11	2.87	2.80*	2.70	2.63	
		tan δ	140	65	120	440	940	860	460	190*	150	100	
Royalite 149-11[b]	25	ϵ'/ϵ_o	5.41	5.20	5.12	4.87	4.41	3.62	----	3.18*	3.13	3.03	
		tan δ	320	165	250	590	1080	900	----	260*	200	190	
Expanded Royalite M21982-1[b]	25	ϵ'/ϵ_o	1.28	1.26	1.25	1.20	1.15						
(field ⊥ plane of sample)		tan δ	175	108	150	240	184						
(field ∥ plane of sample)	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	1.18*	1.15	1.11	
		tan δ	----	----	----	----	----	----	----	54*	56	36	
Expanded Royalite M22190[b]	25	ϵ'/ϵ_o	1.23	1.22	1.19	1.16	1.14						
(field ⊥ plane of sample)		tan δ	157	111	141	162	143						
(field ∥ plane of sample)	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	1.15*	1.15	1.15	
		tan δ	----	----	----	----	----	----	----	40*	32	31	
h. Neoprene													
Neoprene GN[c]	26	ϵ'/ϵ_o	7.5	6.5	6.2	6.1	5.7	4.7	3.4	----	2.84		
		tan δ	6000	860	330	300	950	2000	1600	----	480		
Neoprene compound[d]	24	ϵ'/ϵ_o	6.70	6.60	5.54	6.47	6.26	5.54	4.5	4.24	4.00	4.00	4
		tan δ	160	110	115	150	380	1190	900	636	339	261	250
	80	ϵ'/ϵ_o	6.70	6.20	6.00	5.86	5.75	5.65	5.2	4.73	4.40	4.40	
		tan δ	2700	430	140	92	93	320	900	1200	960	700	

a. Naugatuck. b. Polystyrene-acrylonitrile and polybutadiene-acrylonitrile (U.S.Rubber). c. Poly-2-chlorobutadiene-1,3 stabilized with tetraethylthiuram disulfide (Du Pont). d. 38% GN, 28.4% Catalpo Clay, 14% blanc fixe, 0.4% Gastex (carbon black), 1.9% paraffin, 3.8% Circo (light process oil), 0.2% stearic acid, 0.8% Neozone A, 0.4% Parazone, 7.6% litharge (DuPont).

*Freq. = $1x10^9$.

I. Solids B. Organic 4. Elastomers (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

1. Thiokol	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Thiokol, Type FA	23	ϵ'/ϵ_o	----	2260	515	200	110	70	30	24	16	14	13.6
compound[a]		tan δ	----	12900	8000	5100	3900	3200	2800	2800	2200	1500	1000
Thiokol PRI	25	ϵ'/ϵ_o	----	17900	15200	7550	740	106	----	20.5*	17.1	8.4	
compound[b]		tan δ	----	36300	56400	88000	40000	27000	----	2600*	2300	2200	
Thiokol ST	25	ϵ'/ϵ_o	----	17300	5100	600	215	90	----	17*	14.8	8.5	
compound[c]		tan δ	----	10000	17000	36000	18000	7600	----	3000*	3600	4000	
j. Silicone Rubbers													
Silastic 120[d]	25	ϵ'/ϵ_o	5.78	5.76	5.75	5.75	5.75	5.75	5.75	5.74	5.73	5.72	
		tan δ	51	30	16	10	8	12	27	52	254	510	
Silastic 125[d]	25	ϵ'/ϵ_o	7.1	7.1	7.0	7.0	6.9	6.9	6.8	----	7		
		tan δ	40	26	18	13	12	14	30	----	430		
Silastic 150[e]	25	ϵ'/ϵ_o	5.87	5.85	5.79	5.61	5.39	5.09	5.0	5.0	5.0	5.0	
		tan δ	43	48	108	200	270	280	230	250	440	800	
Silastic 152[f]	25	ϵ'/ϵ_o	2.96	2.95	2.95	2.95	2.95	2.95	2.95	2.93*	2.90	2.85	
		tan δ	5.8	5.2	4	3.5	5.4	10.4	20	59*	100	167	
Silastic 160[g]	25	ϵ'/ϵ_o	9.32	9.27	9.2	9.0	8.8	8.4	8.0	7.9	7.8	7.6	
		tan δ	47	31	60	150	250	270	310	310	600	1400	
Silastic 167[h]	25	ϵ'/ϵ_o	8.6	8.6	8.6	8.5	8.5	8.5	8.5	----	8		
		tan δ	52	32	19	12	11	13	16	---	360		
Silastic 180[i]	25	ϵ'/ϵ_o	4.66	4.60	4.56	4.53	4.53	4.52	4.5	4.5	4.5	4.5	
		tan δ	67	63	54	40	30	27	35	56	170	320	
Silastic 181[j]	25	ϵ'/ϵ_o	3.36	3.30	3.26	3.23	3.20	3.19	3.18	3.16	3.11	3.09	
		tan δ	62	67	65	58	37	28	29	36	100	174	
Silastic 250[k]	25	ϵ'/ϵ_o	3.19	3.18	3.17	3.16	3.10	3.07	3.05	3.04	3.02	3.00	
		tan δ	55	30	69	106	64	29	28	44	190	200	

a. 100 pts. Thiokol (organic polysulfide), 10 pts. zinc oxide, 60 pts. semi-reinforcing carbon black, 1 pt. stearic acid, 0.5 pt. diphenylguanidine, 0.35 pt. Altax (Thiokol). b. 100 pts. polysulfide copolymer of bis (2-chloroethyl) formal and ethylene dichloride, 60 pts. carbon blacks, compounding ingredients. (Thiokol). c. 100 pts. polysulfide polymer of bis (2-chloroethyl) formal, 60 pts. carbon blacks, compounding ingredients. (Thiokol). d. 50% siloxane elastomer, 50% TiO_2 (Dow Corning). e. 35% siloxane elastomer, 35% ZnO, 30% $CaCO_3$. (Dow Corning). f. Dow Corning. g. 33% siloxane elastomer, 33% ZnO, 33% TiO_2 (Dow Corning). h. 33% siloxane elastomer, 67% TiO_2 (Dow Corning). i. 35% siloxane elastomer, 35% SiO_2, 30% TiO_2 (Dow Corning). j. 45% siloxane elastomer, 55% SiO_2 (Dow Corning). k. 70% siloxane elastomer, 30% SiO_2 (Dow Corning).
*Freq. = $1x10^9$.

I. Solids, B. Organic 4. Elastomers (cont.)   Values for tan δ are multiplied by 10^4; frequency given in c/s.

j. Silicone Rubbers (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Silastic X4342[a]	25	ϵ'/ϵ_o	3.22	3.18	3.16	3.16	3.14	3.12	3.11	3.08	3.08	3.00
		tan δ	51	64	60	48	29	20	23	35	83	110
Silastic 6167[b]	25	ϵ'/ϵ_o	10.1	10.1	10.0	10	10	10	10	10	10	10
		tan δ	41	26	17	13	9.5	10	27	55	450	1000
Silastic 6181[c]	25	ϵ'/ϵ_o	3.66	3.53	3.42	3.35	3.31	3.30	3.27	3.25	3.23	3.20
		tan δ	200	250	190	100	57	34	32	36	88	160
Silastic X-6734[d]	25	ϵ'/ϵ_o	3.21	3.12	3.12	3.12	3.10	3.08	3.08	3.08	3.01	3.00
		tan δ	28	19	31	53	37	23	29	44	144	213
Silastic 7181[c]	25	ϵ'/ϵ_o	3.72	3.55	3.45	3.37	3.33	3.31	3.31	3.28	3.20	3.15
		tan δ	210	250	190	97	53	29	24	29	75	170
SE-450[e]	25	ϵ'/ϵ_o	3.09	3.08	3.08	3.08	3.07	3.06	3.05	3.00*	2.97	2.88
		tan δ	16	7.2	5.3	7	11	17	30	74*	158	183
SE-460[e]	25	ϵ'/ϵ_o	3.14	3.12	3.11	3.10	3.10	3.09	3.07	3.05*	3.02	2.94
		tan δ	56	54	44	25	12	15	23	57*	98	180
SE-550[e]	25	ϵ'/ϵ_o	3.14	3.12	3.10	3.10	3.10	3.08	3.06	3.02*	3.00	2.94
		tan δ	13	7.8	6.5	7	9.5	16	31	84*	143	195
SE-972[e]	25	ϵ'/ϵ_o	3.40	3.35	3.25	3.22	3.20	3.18	3.16	3.15*	3.13	3.08
		tan δ	64	67	58	46	30	27	32	65*	97	146
5. Natural Resins												
Amber[f]	25	ϵ'/ϵ_o	2.7	2.7	2.7	2.7	2.65	2.65	----	2.6	2.6	
		tan δ	12.5	18	31	43	56	68	----	82	90	
	80	ϵ'/ϵ_o	2.85	2.85	2.85	2.8	2.8	2.75	----	2.65	2.60	
		tan δ	24	19	22	40	70	93	----	110	115	
Shellac, natural XL[g]	28	ϵ'/ϵ_o	3.86	3.81	3.75	3.66	3.47	3.26	3.10	----	2.86	
		tan δ	65	74	128	225	310	350	300	----	254	
	70	ϵ'/ϵ_o	6.50	5.65	5.10	4.60	4.33	4.00	3.80	----	3.45	
		tan δ	1050	860	650	460	400	540	700	----	732	

a. 50% siloxane elastomer, 50% SiO_2 (Dow Corning). b. 33% siloxane elastomer, 67% TiO_2 (Dow Corning). c. 45% siloxane elastomer, 55% SiO_2 (Dow Corning). d. 70% siloxane elastomer, 30% SiO_2 (Dow Corning). e. General Electric. f. Fossil resin (Amber Mines). g. Contains ca. 3.5% wax (Zinsser).

*Freq. = $1x10^9$.

I. Solids B. Organic (Cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
5. Natural Resins (cont.)													
Shellac, natural	27	ϵ'/ϵ_o	3.84	3.82	3.75	3.66	3.50	3.30	3.1	----	2.86		
Zinfo[a]		tan δ	58	64	132	250	313	341	345	----	290		
Shellac, pure C	28	ϵ'/ϵ_o	3.99	3.92	3.84	3.69	3.50	3.32	3.2	----	2.94		
garnet[b]		tan δ	137	102	131	205	304	347	340	----	270		
Shellac, garnet	26	ϵ'/ϵ_o	3.60	3.56	3.48	3.40	3.30	3.20	3.05	----	2.75		
dewaxed[c]		tan δ	58	64	118	205	285	317	310	----	267		
Chemlac B-3[d]	23	ϵ'/ϵ_o	3.19	3.12	3.09	3.04	3.00	2.98	2.98	2.91	2.90	2.87	
		tan δ	105	85	86	91	100	110	118	125	135	120	
6. Asphalts and Cements													
Gilsonite[e]	26	ϵ'/ϵ_o	2.68	2.66	2.63	2.61	2.58	2.57	2.56	----	----	2.55	
		tan δ	58	35	25	19	16	13	11	----	----	9.3	
Millimar[f]	22	ϵ'/ϵ_o	2.65	2.65	2.65	2.64	2.64	2.64	2.64	----	2.5	2.5	
		tan δ	39	35	26	14	11	10	11	----	11	12	
Cenco Sealstix[g]	23	ϵ'/ϵ_o	3.90	3.75	3.55	3.37	3.23	3.13	----	----	2.96		
		tan δ	452	335	275	240	240	272	----	----	210		
Plicene Cement[h]	25	ϵ'/ϵ_o	2.48	2.48	2.48	2.48	2.48	2.48	2.47	----	2.40	2.35	
		tan δ	43.9	35.5	28.9	25.9	25.5	22.2	15	----	7.8	6.8	
7. Waxes													
Acrawax C[i]	24	ϵ'/ϵ_o	2.60	2.58	2.57	2.55	2.54	2.53	2.52	----	2.48	2.45	2.44
		tan δ	157	68	45	30	20	15	12	----	15	19	21
	85	ϵ'/ϵ_o	----	5.0	3.2	2.63	2.50	2.46	----	----	2.45		
		tan δ	----	7000	3500	560	180	130	----	----	228		
Apiezon Wax "W"[j]	22	ϵ'/ϵ_o	2.75	2.69	2.66	2.64	2.63	2.63	----	----	2.62		
		tan δ	186	120	70	39	25	19	----	----	16		
	70	ϵ'/ϵ_o	3.29	3.14	2.97	2.88	2.82	2.79					
		tan δ	450	420	340	210	110	61					

a. Contains ca. 3.5% wax (Zinsser). b. Natural, ca. 2% wax (Zinsser). c. Natural, wax-free (Zinsser). d. From zein and rosin (Filtered Rosin Products). e. 99.9% natural bitumen (U.S.Rubber). f. Asphaltic product (U.S.Rubber). g. De Khotinsky Cement (Central Scientific). h. Central Scientific. i. Cetylacetamide (Glyco). j. Shell Oil.

I. Solids B. Organic (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

7. Waxes (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Beeswax, white[a]	23	ϵ'/ϵ_o	2.65	2.63	2.56	2.48	2.43	2.41	2.39	----	2.35	2.35	
		tan δ	140	118	266	190	84	68	60	----	50	48	
	55	ϵ'/ϵ_o	2.52	2.50	2.46	2.43	2.39	2.36	2.34	----	2.31		
		tan δ	82	44	25	25	35	58	125	----	216		
Beeswax, yellow[b]	23	ϵ'/ϵ_o	2.73	2.66	2.59	2.53	2.49	2.45	2.42	----	2.39	2.36	
		tan δ	240	140	240	150	92	84	90	----	75	62	
Cerese Wax AA[c]	24*	ϵ'/ϵ_o	2.35	2.35	2.35	2.34	2.33	2.32	----	----	2.29	2.27	
		tan δ	5	6	7	8	8	7	----	----	4.6	5.0	
	46*	ϵ'/ϵ_o	2.35	2.35	2.35	2.34	2.33	2.32	----	----	2.28	2.27	
		tan δ	< 5	< 3	3	5	8	10	----	----	6.2	6	
Cerese Wax, brown[c]	22	ϵ'/ϵ_o	----	2.28	2.28	2.28	2.28	2.28	2.27	----	2.25		
		tan δ	----	5	10	13	11	7	2	----	2.8		
Ceresin, white[d]	25	ϵ'/ϵ_o	2.3	2.3	2.3	2.3	2.3	2.3	2.3	----	2.25	2.24	
		tan δ	8	6	5	5	4	4	4	----	4.6	6.5	
Ceresin, yellow[e]	20	ϵ'/ϵ_o	----	2.25	2.25	2.25	2.25	2.25	2.25	----	2.25	2.25	
		tan δ	----	4	5	7	7	5	4	----	4.2	4	
Estawax[f]	25	ϵ'/ϵ_o	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.29	2.28	2.28
		tan δ	7	< 2	2	4	5	4	2.5	2.3	2.9	3.7	4.6
	80	ϵ'/ϵ_o	2.18	2.18	2.18	2.18	2.18	2.18	2.18	2.18	2.17	2.15	
		tan δ	11	7	3	< 2	< 2	< 4	5	6.4	7.9	8.5	
Halowax #1001[g] cold-molded	26	ϵ'/ϵ_o	5.45	5.45	5.45	5.40	5.40	5.30	4.2	3.46	2.92	2.36	2.84
		tan δ	18	17	7	8	45	450	2700	1620	583	296	200
hot-molded	25	ϵ'/ϵ_o	3.78	3.78	3.76	3.74	3.70	3.62	3.37	3.17	2.57		
		tan δ	16	8	6	8.6	32	400	1200	1210	496		

a. Bromund. b. Candy. c. Mainly petroleum aliphatic hydrocarbons (Socony-Vacuum). d. Vegetable and mineral waxes (Kuhne-Libby). e. Vegetable and mineral waxes (Mitchell-Rand). f. Long-chain, singly unsaturated (Lovell). g. Tri- and tetrachloronaphthalenes (Bakelite).

*Similar data were obtained after incorporation of 0.5% phenyl mercuric stearate.

I. Solids B. Organic (Cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

7. Waxes (cont.)	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	3.10^9	$1x10^{10}$	$2.5x10^{10}$
Halowax #11-314[a]	23	ϵ'/ϵ_o	3.11	3.04	3.01	2.99	2.98	2.96	2.93	2.92	2.89	2.87	
		tan δ	700	110	17	5	3	7	17	38	37	9.5	
	45	ϵ'/ϵ_o	3.11	3.04	3.01	2.99	2.98	2.96	2.93	----	----	2.87	
		tan δ	700	110	17	5	3	3	5	----	----	31	
Kel-F Wax #150[b]	25	ϵ'/ϵ_o	3.01	2.97	2.91	2.75	2.52	2.35	2.25	2.24	2.23	2.22	
		tan δ	83	93	252	510	540	425	270	218	113	90	
Opalwax[c]	24	ϵ'/ϵ_o	13.2	10.3	7.0	4.3	3.2	2.9	2.7	----	2.55	2.52	2.5
		tan δ	1250	2100	2900	2700	1450	580	270	----	167	160	160
	47	ϵ'/ϵ_o	14.2	11.4	8.2	5.4	3.7	3.0	2.7	----	----	2.47	
		tan δ	450	1300	2600	3000	2100	860	430	----	-----	236	
Ozokerite[d]	20	ϵ'/ϵ_o	2.26	2.26	2.26	2.26	2.26	2.26	2.26	----	2.26		
		tan δ	6	6	8	10	9	7	6	----	6		
Paraffin Wax 132° ASTM[e]	25	ϵ'/ϵ_o	2.25	2.25	2.25	2.25	2.25	2.25	2.25	----	2.25	2.24	2.2
		tan δ	< 2	< 2	< 2	< 2	< 2	< 2	< 2	----	2.0	2.1	< 3
	81	ϵ'/ϵ_o	2.02	2.02	2.02	2.02	2.02	2.02	----	----	2.00		
		tan δ	5	1.2	.5	< 2	< 2	< 3	----	----	5.2		
Paraffin Wax 135° AMP[f]	24	ϵ'/ϵ_o	2.25	2.25	2.25	2.25	2.25	2.25	----	----	2.22	2.22	
		tan δ	12.5	5.5	< 3	< 2	< 2	< 4	----	----	1	2	
Parowax[g]	20	ϵ'/ϵ_o	----	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	
		tan δ	----	2	2	2	3	2	1.4	1	2	2.5	
Polinel[h]	25	ϵ'/ϵ_o	2.89	2.87	2.87	2.85	2.84	2.80	2.72	2.62*	2.59	2.58	
		tan δ	67	44	36	43	82	166	240	180*	195	199	
Sealing wax, Red Express[i]	25	ϵ'/ϵ_o	3.68	3.52	3.40	3.32	3.29	3.27	3.2	----	3.09		
		tan δ	249	150	99	79	80	100	120	----	122		
Thermoplastic Composition 1766EX[j]	25	ϵ'/ϵ_o	3.77	3.72	3.68	3.63	3.60	3.58	3.56	----	----	3.58	
		tan δ	122	106	87	60	44	32	28	----	----	20	
Thermoplastic Composition 3738[j]	25	ϵ'/ϵ_o	2.65	2.60	2.57	2.56	2.55	2.54	2.54	2.52*	2.52	2.49	
		tan δ	112	91	67	41	25	16	15	13*	13	13	

a. 80% 1,4-, 10% 1,5-, 10% 1,2-dichloronapthalenes (Bakelite). b. Polychlorotrifluoroethylene (Kellogg). c. Mainly 12-hydroxystearin (DuPont). d. Natural paraffin (Allison). e. Mainly C_{22} to C_{29} aliphatic, saturated hydrocarbons (Stand. Oil N.J.). f. Gulf. g. Paraffin wax (Socony Vacuum). h. Lovell. i. Dennison. j. Mitchell-Rand.
*Freq. =$1x10^9$.

I. Solids B. Organic (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

7. Waxes (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Thermoplastic composition	25	ϵ'/ϵ_o	2.84	2.79	2.76	2.64	2.59	2.54	2.51	2.48	2.45	2.45	
3767A[a]		tan δ	140	160	170	120	98	78	69	59	32	27	
Vistawax[b]	25	ϵ'/ϵ_o	2.34	2.34	2.34	2.34	2.34	2.32	2.30	----	2.27	2.26	
		tan δ	2	3	9.2	12.1	13.3	13.6	13.3	----	9.0	5	
Wax 3760[c]	25	ϵ'/ϵ_o	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.31*	2.31	2.31	
		tan δ	21.7	8.8	7.1	5.6	4.3	2.7	2.6	3.6*	4.9	14.2	
Wax S-1167[d]	25	ϵ'/ϵ_o	19.9	10.2	5.9	4.1	3.3	3.1	2.9	2.6	2.6	2.6	
		tan δ	7200	3900	2300	1700	1000	600	470	300	190	92	
Wax S-1184[d]	25	ϵ'/ϵ_o	2.43	2.43	2.43	2.40	2.40	2.40	2.37	2.34*	2.30	2.21	
		tan δ	29.4	21.5	21.5	16.4	11.3	9.3	13.8	20*	24	54	
Wax Compound F-590[e]	26	ϵ'/ϵ_o	2.37	2.34	2.32	2.32	2.32	2.32	2.32	----	2.32		
		tan δ	80	99	78	44	20	8	5	----	6.2		
Wax Compound #1340[e]	26	ϵ'/ϵ_o	2.30	2.30	2.30	2.30	2.30	2.30	2.30	----	2.25		
		tan δ	1	2	2	< 5	4	4	4	----	4.2		
8. Woods													
Balsa	26	ϵ'/ϵ_o	1.4	1.4	1.4	1.4	1.37	1.35	1.30	----	1.22	1.20	
		tan δ	50	40	43	77	120	135	135	----	100	83	
Yellow Birch	25	ϵ'/ϵ_o	2.91	2.88	2.82	2.78	2.70	2.60	2.47	2.40	2.13	1.95	1.87
(field ⊥ to grain)		tan δ	72	90	140	220	290	360	400	390	330	280	260
Fir, Douglas	25	ϵ'/ϵ_o	2.04	2.00	1.97	1.95	1.93	1.90	1.88	1.86	1.82	1.80	1.78
(field ⊥ to grain)		tan δ	48	80	130	190	260	310	330	320	270	290	320
Fir, Douglas, plywood	25	ϵ'/ϵ_o	2.1	2.1	2.05	1.95	1.90	1.80	----	1.7	----	----	1.5
(field ⊥ to grain)		tan δ	115	105	130	170	230	320	----	360	----	----	220
Fir, Douglas, staypak	25	ϵ'/ϵ_o	7.3	7.05	6.9	6.65	6.3	5.6	4.6	4.0	3.5	3.3	3.2
(field ⊥ to grain)		tan δ	82	130	200	320	500	750	800	850	700	550	460
Mahogany	25	ϵ'/ϵ_o	2.42	2.40	2.36	2.30	2.25	2.17	2.07	2.01	1.88	1.7	1.6
(field ⊥ to grain)		tan δ	86	120	150	195	250	310	320	300	250	210	200
Poplar, yellow	25	ϵ'/ϵ_o	1.84	1.79	1.78	1.76	1.75	1.70	----	1.60	1.50	1.42	1.4
(field ⊥ to grain)		tan δ	42	54	83	133	190	220	----	200	150	200	170

a. Mitchell-Rand. b. Polybutene (Cantol Wax). c. Mitchell-Rand. d. Glyco. e. Zophar Mills.

*Freq. = $1x10^9$.

I. Solids B. Organic (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

9. Miscellaneous	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Paper, Royalgrey[a]	25	ϵ'/ϵ_o	3.30	3.29	3.22	3.10	2.99	2.86	2.77	2.75	2.70	2.62	
		tan δ	58	77	117	200	380	570	660	660	560	403	
	82	ϵ'/ϵ_o	3.57	3.52	3.49	3.40	3.31	3.14	3.08	3.00	2.94	2.84	
		tan δ	170	74	61	85	230	440	630	720	800	827	
Leather, sole, dried	25	ϵ'/ϵ_o	4.1	3.9	3.6	3.4	3.2	3.1	3.1				
		tan δ	450	350	300	280	280	300	380				
Leather, sole, ca.	25	ϵ'/ϵ_o	38	14.0	9.3	6.9	5.6	4.9	4.5				
15% moisture		tan δ	14000	7000	3700	2200	1400	1000	1000				
Soap, Ivory[b]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	2.96		
		tan δ	----	----	----	----	----	----	----	----	1765		
Steak (bottom round)	25	ϵ'/ϵ_o	----	----	24400	----	197	50	----	50	40	30	15
		tan δ	----	----	405000	----	610000	260000	----	7800	3000	3700	4000
Suet	25	ϵ'/ϵ_o	----	750	210	----	14	4.5	2.6	2.5	2.5	2.5	2.4
		tan δ	----	30000	25000	----	17000	9300	1500	1200	700	500	500

a. Rogers. b. Procter and Gamble.

II. LIQUIDS

Values for tan δ are multiplied by 10^4; frequency given in c/s.

	T^oC		$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$ **
A. Inorganic										
Water, conductivity[a]	1.5	ϵ'/ϵ_o	87.0	87.0	87	87	86.5	80.5	38	15
		tan δ	1900	190	20	70	320	3100	10300	4250
	5	ϵ'/ϵ_o	----	85.5	----	----	85.2	80.2	41	17.5
		tan δ	----	220	----	----	273	2750	9500	3950
	15	ϵ'/ϵ_o	----	81.7	----	----	81.0	78.8	49	25
		tan δ	----	310	----	----	210	2050	7000	3300
	25	ϵ'/ϵ_o	78.2	78.2	78.2	78	77.5	76.7	55	34
		tan δ	4000	400	46	50	160	1570	5400	2650
	35	ϵ'/ϵ_o	----	74.8	----	----	74.0	74.0	58	41
		tan δ	----	485	----	----	125	1270	4400	2150
	45	ϵ'/ϵ_o	----	71.5	----	----	71.0	70.7	59	46
		tan δ	----	590	----	----	105	1060	4000	2750
	55	ϵ'/ϵ_o	----	68.2	----	----	68	67.5	60	49
		tan δ	----	720	----	----	92	890	3600	2450
	65	ϵ'/ϵ_o	----	64.8	----	----	64.5	64.0	59	50.5
		tan δ	----	865	----	----	84	765	3200	1250
	75	ϵ'/ϵ_o	----	61.5	----	----	61	60.5	57	51.5
		tan δ	----	1030	----	----	77	660	2800	1050
	85	ϵ'/ϵ_o	58	58	58	58	57	56.5	54	
		tan δ	12400	1240	125	30	73	547	2600	
	95	ϵ'/ϵ_o	----	55	----	----	52	52		
		tan δ	----	1430	----	----	70	470		
Aqueous sodium chloride[b]										
0.1 molal solution	25	ϵ'/ϵ_o	78.2*	----	----	----	76	75.5	54	
		tan δ	24,000,000	----	----	----	7800	2400	5600	
0.3 molal solution	25	ϵ'/ϵ_o	78.2*	----	----	----	71	69.3	52	
		tan δ	63,000,000	----	----	----	24000	4350	6050	
0.5 molal solution	25	ϵ'/ϵ_o	78.2*	----	----	----	69	67.0	51	
		tan δ	99,000,000	----	----	----	39000	6250	6300	
0.7 molal solution	25	ϵ'/ϵ_o	78.2*	----	----	----	----	----	50	
		tan δ	130,000,000	----	----	----	----	----	6600	

a. Research Laboratory of Physical Chemistry, M.I.T. b. NaCl, Mallinckrodt's Analytical Reagent.

*. ϵ'/ϵ_o of conductivity water assumed for purpose of calculating tan δ from conductivity measurements.

** Data of Collie, Hasted and Ritson, Proc. Phys. Soc. 60, 145 (1948).

II. Liquids B. Organic Values for tan δ are multiplied by 10^4; frequency given in c/s.

1. Aliphatic

	$T^{o}C$		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Heptane[a]	25	ϵ'/ϵ_o	1.971	1.971	1.971	----	----	----	----	1.97	1.97	1.97
		tan δ	< 3	< 0.4	< 0.4	----	----	----	----	< 2.5	1	16
Methyl alcohol[b]	25	ϵ'/ϵ_o	----	----	----	----	31	31.0	31.0	30.9	23.9	8.9
		tan δ	----	----	----	----	2000	260	380	800	6400	8100
Ethyl alcohol[c]	25	ϵ'/ϵ_o	----	----	----	----	24.5	24.1	23.7	22.3	6.5	1.7
		tan δ	----	----	----	----	900	330	620	2700	2500	680
n-Propyl alcohol[d]	25	ϵ'/ϵ_o	----	----	----	----	20.1	20.1	19.0	16.0	3.7	2.3
		tan δ	----	----	----	----	180	170	2000	4200	6700	900
n-Butyl alcohol[d]	25	ϵ'/ϵ_o	----	----	----	17.4	17.4	17.4	14.8	11.5	3.5	
		tan δ	----	----	12000	1000	95	240	2700	5500	4700	
Ethylene Glycol[e]	25	ϵ'/ϵ_o	----	----	42	41	41	41	41	39	12	7
		tan δ	----	----	30000	3000	300	80	450	1600	10000	7800
Butyraldehyde[e]	25	ϵ'/ϵ_o	----	6.7	6.7	----	6.7					
		tan δ	----	51000	5200	----	50					
Dibutyl sebacate[f]	26	ϵ'/ϵ_o	4.92	4.73	4.63	4.60	4.58	4.56	----	4.55	3.80	
		tan δ	790	110	14	3	3	16	----	383	2120	
Dioctyl sebacate[f]	26	ϵ'/ϵ_o	4.05	4.05	4.03	4.02	4.01	4.00	----	3.77	2.75	
		tan δ	85	12	5	4	7	55	----	1040	1290	
Carbon tetrachloride[g]	25	ϵ'/ϵ_o	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17
		tan δ	60	8	0.4	< 0.4	< 0.4	< 2	< 2	< 1	4	16
Tetrachloroethylene[h]	25	ϵ'/ϵ_o	2.28	2.28	2.28	2.28	2.28	2.28	----	----	2.28	
		tan δ	15	2	0.7	1	2	2	----	----	10	
Hexachlorobutadiene[i]	25	ϵ'/ϵ_o	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.51	2.47
		tan δ	3	1.5	1	< 1	< 1	2	16	55	240	130

a. Practical (Solvents Supply Laboratory, M.I.T.). b. Absolute, analytical grade (Mallinckrodt). c. Absolute (U.S. Industrial Chemicals). d. Eastman Kodak. Dried and refractionated, Lab. Ins. Res. e. Eastman Kodak. f. Resinous Products. g. Purified, Lab. Ins. Res. h. Eastman Kodak, fractionated Lab. Ins. Res. i. Hooker, fractionated Lab. Ins. Res.

II. Liquids B. Organic (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

	$T^{o}C$		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$1x10^9$	$3x10^9$	$1x10^{10}$
1. Aliphatic (Cont.)													
Dichloropentanes #40[a]	25	ϵ'/ϵ_o	----	334	17.1	8.65	----	7.76	----	7.57	----	6.81	
		tan δ	----	5200000	1060000	135000	----	2700	----	840	----	1980	
Dichloropentanes #14[a]	25	ϵ'/ϵ_o	----	----	8.24	8.06	8.05	8.05	----				
		tan δ	----	----	7500	720	85	16					
Kel-F Oil, Grade #1[b]	25	ϵ'/ϵ_o	2.61	2.61	2.61	2.60	2.61	2.61	2.58	2.53	----	2.34	2.15
		tan δ	22	2.3	.3	1.3	2.0	17	140	380	----	870	860
Kel-F Oil, Grade #3[b]	25	ϵ'/ϵ_o	2.73	2.73	2.73	2.73	2.73	2.73	----	2.48	----	2.22	2.12
		tan δ	7.9	.8	< .3	1.3	7.3	65	----	930	----	696	420
Kel-F Oil, Grade #10[b]	25	ϵ'/ϵ_o	2.83	2.83	2.83	2.83	2.83	2.78	----	2.40	----	2.26	2.13
		tan δ	2.1	.45	1.1	6.1	68	393	----	820	----	300	274
Kel-F Grease #40[b]	25	ϵ'/ϵ_o	2.88	2.88	2.88	2.86	2.78	2.57	----	2.25	----	2.20	2.19
		tan δ	5.4	3.8	18	111	430	570	----	350	----	140	106
Perfluorodihexyl ether (experimental)[c]	25	ϵ'/ϵ_o	1.871	1.871	1.871	----	1.87	1.87	----	1.86	----	1.86	1.85
		tan δ	0.8	0.3	< .4	----	.3	3.5	----	55	----	122	920
Heptacosafluorotributyl amine (exp.)[c]	25	ϵ'/ϵ_o	1.853	1.853	1.853	1.853	1.85	1.85	1.85	1.85	----	1.85	1.85
		tan δ	.15	< .1	< 1	< 1	< 1	1.2	11	25	----	28	20
2. Aromatic													
HB-40 oil[d]	25	ϵ'/ϵ_o	2.59	2.59	2.59	2.59	2.58	2.57	2.54	2.48	----	2.40	2.34
		tan δ	1.3	< .4	< .4	< 3	13	76	160	93	----	30	17
Pyranol 1467[e]	25	ϵ'/ϵ_o	4.42	4.40	4.40	4.40	4.40	4.40	4.08	3.19	----	2.84	2.62
		tan δ	36	3	< 4	3.6	25	260	1300	1500	----	1200	740
Aroclor 1221[f]	25	ϵ'/ϵ_o	----	----	----	----	4.55	4.53	4.35	3.85	3.10	2.75	2.65
		tan δ	----	----	----	----	9	80	800	2000	1900	1030	590
Aroclor 1232[g]	25	ϵ'/ϵ_o	----	----	----	----	5.88	5.85	4.60	3.65	3.00	2.82	2.75
		tan δ	----	----	----	----	22	220	2600	3240	2000	95	51
Aroclor 1242[h]	25	ϵ'/ϵ_o	----	----	----	----	5.89	5.85	3.50	2.93	2.80	2.72	2.69
		tan δ	----	----	----	----	70	700	3000	1850	780	400	223
Aroclor 1248[i]	25	ϵ'/ϵ_o	----	----	----	5.58	5.57	5.10	2.80	2.76	2.78	2.71	2.68
		tan δ	----	----	----	26	260	1900	1000	410	300	151	118
Aroclor 1254[j]	25	ϵ'/ϵ_o	----	----	5.05	5.04	3.70	2.90	2.75	2.72	2.71	2.70	2.69
		tan δ	----	----	42	415	2380	1130	170	78	52	44	40

a. Sharples. b. Polychlorotrifluoroethylene (Kellogg). c. Minn. Mining. d. Monsanto. e. Chlorinated benzenes and diphenyls (Gen. Elec.). f. Monochlorobiphenyl (Monsanto). g. Dichlorobiphenyl (Monsanto). h. Trichlorobiphenyl (Monsanto). i. Tetrachlorobiphenyl (Monsanto). j. Pentachlorobiphenyl (Monsanto).

II. Liquids B. Organic (cont.)

Values for tan δ are multiplied by 10^4; frequency given in c/s.

2. Aromatic (cont.)	T^oC		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
Pyranol 1476[a]	26	ϵ'/ϵ_o	5.04	5.04	5.04	4.91	3.85	2.81	----	2.74	2.70	2.70
		tan δ	.6	6	54	480	2500	1100	----	130	42	38
Aroclor 1260[b]	25	ϵ'/ϵ_o	4.33	4.26	3.46	2.89	2.83	2.79	----	2.73	----	2.72
		tan δ	86	593	1500	645	185	37	----	4.6	----	9.4
Aroclor 1262[c]	25	ϵ'/ϵ_o	4.03	3.44	2.86	2.76	2.75	2.75	----	----	2.75	2.75
		tan δ	392	1400	683	186	46	15.7	----	----	6.0	4.9
Aroclor 5442[d]	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	2.78	2.78
		tan δ	----	----	----	----	----	----	----	----	7.2	7.2
Halowax oil 1000[e]	25	ϵ'/ϵ_o	4.77	4.76	4.76	4.75	4.74	----	----	4.67	3.52	2.99
		tan δ	490	50	5	< 1	< 2	----	----	500	2500	1900
	80	ϵ'/ϵ_o	4.30	4.30	4.30	4.29	4.26	----	----	4.16	3.96	3.30
		tan δ	7800	930	80	15	11	----	----	170	1400	2800
Nitrobenzene[f]	25	ϵ'/ϵ_o	----	----	36	36	35.6	34.4	----	----	31.1	
		tan δ	----	----	3900	350	80	90	----	----	1660	
Styrene N-100[g]	22	ϵ'/ϵ_o	2.40	2.40	2.40	2.40	2.40	2.40	----	----	2.40	2.36
		tan δ	38	5	< 1	< 3	< 3	< 3	----	----	20	58
Styrene N-100,[g] purified[h]	25	ϵ'/ϵ_o	2.40	2.40	2.40	2.40	----	----	----	----	2.38	2.38
		tan δ	15	1.8	< 0.5	< 3	----	----	----	----	13	37
Styrene N-100,[g] sat. with water	27	ϵ'/ϵ_o	2.40	2.40	2.40	----	----	----	----	----	2.40	
		tan δ	47	4.8	1.8	----	----	----	----	----	14	
Styrene dimer[g]	25	ϵ'/ϵ_o	----	----	----	2.7	2.7	2.7	2.7	----	2.5	
		tan δ	----	----	----	9	3	2	18	----	110	
2,5-Dichlorostyrene[i]	24	ϵ'/ϵ_o	2.58	2.58	2.58	2.58	2.58	2.58	----	2.58	2.52	
		tan δ	85	9	1	< 5	< 3	< 3	----	37	114	
Pyranol 1478[j]	26	ϵ'/ϵ_o	4.55	4.53	4.53	4.53	4.53	4.53	----	4.50	3.80	
		tan δ	150	14	2	< 5	2	12	----	381	2310	
β-chloroethyl-2,5-dichlorobenzene[k]	24	ϵ'/ϵ_o	----	6.05	5.45	5.22	5.20	5.20	5.20	5.18	3.31	
		tan δ	----	5000	500	25	5	30	430	1100	3240	
Ethylpolychlorobenzene[m] (discontinued)	25	ϵ'/ϵ_o	4.12	4.12	4.12	4.12	4.12	4.12	4.10	3.84	2.70	2.55
		tan δ	13.6	1.3	1	< 2	6	55	550	1400	1260	660
	100	ϵ'/ϵ_o	3.62	3.62	3.62	3.62	3.62	3.62	----	3.46	3.12	2.59
		tan δ	380	40	3.7	< 1	1	5	----	220	1720	3800

a. Isomeric pentachlorodiphenyls (Gen. Elec.). b. Hexachlorobiphenyl (Monsanto). c. Heptachlorobiphenyl (Monsanto). d. Pentachloroterphenyls (Monsanto). e. 60% mono-, 40% di- and trichloronaphthalenes (Bakelite). f. Purified Lab. Ins. Res. g. Dow Chemical Co. h. Fractionated (Lab. Ins. Res.). i. Monsanto (fractionated Lab. Ins. Res.). j. Isomeric trichlorobenzenes (Gen. Elec.). k. Monsanto. m. DuPont.

II. Liquids, B. Organic (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

3. Petroleum Oils	T°C		1x10^2	1x10^3	1x10^4	1x10^5	1x10^6	1x10^7	1x10^8	3x10^8	3x10^9	1x10^10
Aviation gasoline	25	ϵ'/ϵ_o	----	----	1.94	----	----	----	----	1.94	1.92	
100 octane		tan δ	----	----	1	----	----	----	----	.8	14	
Aviation gasoline	25	ϵ'/ϵ_o	----	----	1.95	----	----	----	----	1.95	1.94	
91 octane		tan δ	----	----	4	----	----	----	----	.4	11.5	
Jet fuel JP-1	25	ϵ'/ϵ_o	----	----	2.12	----	----	----	----	2.12	2.09	
		tan δ	----	----	< 1	----	----	----	----	12	68	
Jet fuel JP-3	25	ϵ'/ϵ_o	----	----	2.08	----	----	----	----	2.08	2.04	
		tan δ	----	----	< 1	----	----	----	----	7	55	
Kerosene	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	----	2.09	
		tan δ	----	----	----	----	----	----	----	----	45	
Vaseline	25	ϵ'/ϵ_o	2.16	2.16	2.16	2.16	2.16	2.16	2.16	----	2.16	2.16
		tan δ	3	2	< 2	< 1	< 1	< 3	< 4	----	6.6	10
	80	ϵ'/ϵ_o	2.10	2.10	2.10	2.10	2.10	----	----	----	2.10	2.10
		tan δ	16	3.6	.9	< 1	< 1	----	----	----	9.2	22
Cable Oil 5314[a]	25	ϵ'/ϵ_o	2.25	2.25	2.25	2.25	----	----	----	2.24	2.22	2.22
		tan δ	3	< 0.4	< 0.4	< 1	----	----	----	39	18	22
	80	ϵ'/ϵ_o	2.18	2.18	2.18	----	----	----	----	----	2.18	
		tan δ	38	4	0.5	----	----	----	----	----	47	
Cable Oil PL101270[b]	26	ϵ'/ϵ_o	2.20	2.20	2.19	2.18	2.18	2.17	2.17	2.17	2.16	2.16
		tan δ	1.3	0.9	0.6	3	17	42	51	43	20	18
Transil Oil 10C[a]	26	ϵ'/ϵ_o	2.22	2.22	2.22	2.22	2.22	2.22	2.20	2.19	2.18	2.10
		tan δ	4	< 1	< 1	< 6	< 5	8	48	55	28	20
Bayol-D[c]	24	ϵ'/ϵ_o	2.06	2.06	2.06	2.06	2.06	2.06	----	----	2.06	2.06
		tan δ	1	< 1	< 1	< 2	< 3	< 3	----	----	13.3	25
Baycl-F[d]	24	ϵ'/ϵ_o	2.14	2.14	2.14	----	----	----	----	----	2.13	2.13
		tan δ	6.7	1.6	< 1	----	----	----	----	----	10.5	14
Marcol[e]	24	ϵ'/ϵ_o	2.14	2.14	2.14	2.14	2.14	2.14	----	----	2.14	2.14
		tan δ	1	< 1	< 1	< 2	< 2	< 3	----	----	9.7	11

a. Aliphatic and aromatic hydrocarbons (Gen. Elec.). b. California Res. Corp. c. 77.6% paraffins, 22.4% naphthenes (Stanco). d. 74.5% paraffins, 25.5% naphthenes (Stanco). e. 72.4% paraffins, 27.6% naphthenes (Stanco).

II. Liquids, B. Organic (cont.) Values for tan δ are multiplied by 10^4; frequency given in c/s.

3. Petroleum Oils (cont.)	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$	$2.5x10^{10}$
Bayol[a]	24	ϵ'/ϵ_o	2.14	2.14	2.14	----	----	----	----	----	2.14	2.14	
		tan δ	12.6	2	< 1	----	----	----	----	----	9.3	18	
Bayol-16[b]	24	ϵ'/ϵ_o	2.15	2.15	2.15	2.15	2.15	2.15	----	----	2.15	2.15	
		tan δ	7.7	1	< 1	< 2	< 2	< 3	----	----	9.9	13.5	
Fractol A[c]	26	ϵ'/ϵ_o	2.17	2.17	2.17	2.17	----	2.17	----	----	2.17	2.16	2.12
		tan δ	< 1	< 1	< 1	< 2	----	< 3	----	----	7.2	11.3	19
Primol-D[d]	24	ϵ'/ϵ_o	2.17	2.17	2.17	2.17	2.17	2.17	----	----	2.17	2.16	
		tan δ	< 1	< 1	< 1	< 2	< 2	< 3	----	----	7.7	10.6	
Diala Oil 15[e]	25	ϵ'/ϵ_o	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.12
		tan δ	<0.8	<0.8	< 0.4	< 5	< 3	3	10	16.3	13.4	18.6	20
4. Silicones													
DC500	-15	ϵ'/ϵ_o	2.20	2.20	2.20	2.20	2.20	2.20	----	----	2.20		
0.65 cs. at 25°C[f]		tan δ	< 5	< 3	< 3	< 5	< 3	< 2	----	----	18.6		
	22	ϵ'/ϵ_o	2.20	2.20	2.20	2.20	2.20	2.20	----	2.20	2.20	2.19	2.13
		tan δ	1	<0.4	< 0.4	< 3	< 3	< 2	----	1.4	14.5	30	60
DC500	23	ϵ'/ϵ_o	2.66	2.66	2.66	2.66	2.66	2.66	----	----	2.65	2.63	2.48
10 cs. at 25°C[f]		tan δ	12	1.5	< 0.4	< 3	< 3	3	----	----	68	270	410
DC500	22	ϵ'/ϵ_o	2.76	2.76	2.76	----	----	----	----	----	2.75	2.72	2.61
100 cs. at 25°C[f]		tan δ	0.4	<0.4	< 0.4	----	----	----	----	----	94	240	390
DC200	23	ϵ'/ϵ_o	2.76	2.76	2.76	----	----	----	----	----	2.76	2.70	2.55
100 cs. at 25°C[f]		tan δ	0.8	0.4	< 0.4	----	----	----	----	----	96	320	550
DC200	22	ϵ'/ϵ_o	2.78	2.78	2.78	2.78	2.78	2.78	----	----	2.74	2.74	
1000 cs. at 25°C[f]		tan δ	0.8	0.8	0.6	< 3	< 3	< 2	----	----	96	330	
DC200	-17	ϵ'/ϵ_o	2.90	2.90	2.90	2.90	2.90	2.90	----	----	2.87		
7600 cs. at 130°C[f]		tan δ	< 5	< 3	< 3	< 5	< 3	2	----	----	130		
	23	ϵ'/ϵ_o	2.75	2.75	2.75	2.75	2.75	2.75	----	2.74	2.72	2.69	
		tan δ	0.5	0.2	< 0.4	< 5	< 3	2	----	11	103	225	
	83	ϵ'/ϵ_o	2.56	2.56	2.56	2.56	2.56	2.56	----	----	2.55		
		tan δ	< 5	< 3	< 3	< 5	< 3	2	----	----	60		

a. 72.0% paraffins, 28.0% naphthenes (Stanco). b. 68.9% paraffins, 31.1% naphthenes (Stanco). c. 57.4% paraffins, 42.6% naphthenes (Stanco). d. 49.4% paraffins, 50.6% naphthenes (Stanco). e. Petroleum hydrocarbons, mainly naphthenes (Shell). f. Methyl or ethyl siloxane polymer (Dow Corning).

II. Liquids, B. Organic (cont.) **Values for tan δ are multiplied by 10^4; frequency given in c/s.**

	T°C		$1x10^2$	$1x10^3$	$1x10^4$	$1x10^5$	$1x10^6$	$1x10^7$	$1x10^8$	$3x10^8$	$3x10^9$	$1x10^{10}$
4. Silicones (cont.)												
DC550[a]	25	ϵ'/ϵ_o	2.91	2.90	2.90	2.90	2.90	2.88	----	2.88	2.77	2.60
		tan δ	1630	170	18	3.7	3.8	12	----	130	210	220
DC710[a]	25	ϵ'/ϵ_o	2.98	2.98	2.98	2.98	2.98	2.97	----	2.93	2.79	2.60
		tan δ	13	1.6	.7	3	10	50	----	200	140	170
Ignition Sealing Compound #4[b]	25	ϵ'/ϵ_o	2.75	2.75	2.75	2.75	2.75	2.75	2.74	2.72	2.65	2.49
		tan δ	15	6	5	4	4	6	15	28	92	270
	80	ϵ'/ϵ_o	2.6	2.6	2.6	2.6	2.6	----	----	----	2.54	
		tan δ	64	18	6	4	< 4	----	----	----	47	
SF96-40[c]	25	ϵ'/ϵ_o	2.71	2.71	2.71	2.71	2.71	2.71	----	2.71	2.70	2.67
		tan δ	<.3	<.03	<.03	<.3	< 1	< 1	----	11	95	186
SF96-100[c]	25	ϵ'/ϵ_o	2.73	2.73	2.73	2.73	2.73	2.73	----	2.73	2.71	2.69
		tan δ	<.6	<.06	<.03	< 1	< 1	< 1	----	11	107	200
SF96-1000[c]	25	ϵ'/ϵ_o	2.73	2.73	2.73	2.73	2.73	2.73	----	2.73	2.71	2.695
		tan δ	<.3	<.03	<.03	<.3	< 1	.8	----	13	106	203

a. Methyl and methyl phenyl polysiloxane (Dow Corning). b. Organosiloxane polymer (Dow Corning). c. Gen. Elec.

Supplementary High-Temperature Data on Plastics

Frequency given in c/s.

	T^oC		10^2	10^3	10^4	$4x10^4$	10^5	10^6	$3x10^8$	$3x10^9$
Formica FF-41 (after 5 yrs. storage, various samples)	25	ϵ'/ϵ_o	6.27	6.19	6.12	6.08	5.97	----	3.87	4.2
		tan δ	.018	.0085	.0081	.0090	.012	----	.0143	.021
	100	ϵ'/ϵ_o	----	11.2	6.73	6.23	6.07	----	4.00	4.3
		tan δ	----	.50	.18	.055	.040	----	.0144	.020
Formica LE (after 5 yrs. storage)	25	ϵ'/ϵ_o	5.92	5.32	5.01	4.87	4.86	4.85	----	3.63
		tan δ	.112	.057	.038	.036	.040	.042	----	.037
	100	ϵ'/ϵ_o	----	16.0	8.16	6.69	6.22	5.84	----	4.10
		tan δ	----	.42	.29	.173	.151	.080	----	.067
Formica MF-66	200	ϵ'/ϵ_o	----	12.8	7.17	6.4	----	----	----	4.94
		tan δ	----	.847	.245	.134	----	----	----	.059
Formica XX	100	ϵ'/ϵ_o	9.77	6.66	5.87	5.66	5.61	5.44	----	4.09
		tan δ	.42	.195	.073	.046	.035	.029	----	.102
Micarta 259	100	ϵ'/ϵ_o	9.39	6.75	6.14	6.03	----	----	5.2	
		tan δ	.44	.16	.043	.022	----	----	.025	
Micarta 299	200	ϵ'/ϵ_o	12.8	6.7	5.0	4.8	4.75	4.6	4.4	
		tan δ	.59	.36	.158	.081	.046	.015	.016	
Micarta 496 (after 5 yrs. storage)	25	ϵ'/ϵ_o	7.31	6.35	5.89	5.73				
		tan δ	.16	.074	.045	.041				
	100	ϵ'/ϵ_o	----	15.5	8.53	7.42	7.26	6.31		
		tan δ	----	.68	.305	.178	.116	.064		

Supplementary High-Humidity Data

Frequency given in c/s.

	T^oC		10^2	10^3	10^4	10^5	10^6	10^7	$4x10^7$	$3x10^8$	10^{10}
Mycalex 400, dry	25	ϵ'/ϵ_o	7.45	7.45	7.42	7.40	7.39	7.38	7.36	----	7.12
		tan δ	.0029	.0019	.0016	.0014	.0013	.0013	.0012	----	.0033
after 48 hrs. in H_2O	25	ϵ'/ϵ_o	7.45	7.45	7.42	----	7.39	7.38	7.36	----	7.18
		tan δ	.012	.0097	.0068	----	.0029	.0021	.0019	----	.010
Bakelite BM 120, dry	25	ϵ'/ϵ_o	4.87	4.74	4.62	4.50	4.36				
		tan δ	.030	.022	.020	.021	.028				
after 19 days, 90% rel. hum.	25	ϵ'/ϵ_o	7.4	5.4	4.4						
		tan δ	.32	.19	.11						
after 18 mos., 90% rel. hum.	25	ϵ'/ϵ_o	11.1	7.8	6.3	5.4	4.54				
		tan δ	.37	.20	.12	.078	.056				
Bakelite BM 262, dry	25	ϵ'/ϵ_o	4.85	4.80	4.74	4.72	4.67	----	----	----	
		tan δ	.0095	.0082	.0075	.0060	.0055				
after 20 days, 90% rel. hum.	25	ϵ'/ϵ_o	3.87	3.78	3.70						
		tan δ	.0184	.015	.012						
after 7 mos., 90% rel. hum.	25	ϵ'/ϵ_o	6.72	5.78	5.15						
		tan δ	.147	.09	.057						
after 19 mos., 90% rel. hum.	25	ϵ'/ϵ_o	9.10	6.75	5.51	----	4.18				
		tan δ	.244	.169	.111	----	.047				
Bakelite BM 1895, dry	25	ϵ'/ϵ_o	4.80	4.72	4.70	4.67	4.64	----	----	----	
		tan δ	.0087	.0077	.0080	.0065	.0052				
after 20 days, 90% rel. hum.	25	ϵ'/ϵ_o	5.1	5.0	4.9						
		tan δ	.023	.018	.016						
after 19 mos., 90% rel. hum.	25	ϵ'/ϵ_o	----	61.4	24	11.7	8.0				
		tan δ	----	1.04	.75	.41	.22				
Formica FF-55, dry	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	5.55	
		tan δ	----	----	----	----	----	----	----	.027	
after 20 hrs. in H_2O	25	ϵ'/ϵ_o	----	----	----	----	----	----	----	6.5	
		tan δ	----	----	----	----	----	----	----	.054	

Supplementary High-Humidity Data (cont.)

Frequency given in c/s.

	$T^\circ C$		10^2	10^3	10^4	10^5	10^6	$3x10^9$
GMG Melamine, dry	25	ϵ'/ϵ_o	8.2	7.0	6.7	6.6	6.4	
		tan δ	.19	.069	.019	.010	.011	
after 6 or 8 mos., 90% rel.hum.	25	ϵ'/ϵ_o	42.5	16.8	10.4	7.65	6.57	
		tan δ	.75	.54	.27	.10	.030	
Hysol 6030, dry and after 4 days in H_2O, no change at $1x10^9$.								
Lucite HM-119, dry and after 18 months at 90% relative humidity, 25°C, no change in the range 10^2 to 10^6 c/s.								
Lumarith 22361, dry	25	ϵ'/ϵ_o	----	----	----	----	----	2.74
		tan δ	----	----	----	----	----	.0196
after 20 days or more at 90% rel. hum.	25	ϵ'/ϵ_o	----	----	----	----	----	3.14
		tan δ	----	----	----	----	----	.047
Micarta 496, dry	25	ϵ'/ϵ_o	----	----	----	----	----	3.78
		tan δ	----	----	----	----	----	.059
after 24 hrs., 90% rel. hum.	25	ϵ'/ϵ_o	----	----	----	----	----	3.94
		tan δ	----	----	----	----	----	.071
Nylon, See page 23								
Poly-2,5-dichlorostyrene, dry	25	ϵ'/ϵ_o	----	----	----	----	----	2.59
		tan δ	----	----	----	----	----	.00026
after 20 days, 90% rel. hum.	25	ϵ'/ϵ_o	----	----	----	----	----	2.59
		tan δ	----	----	----	----	----	.00055
Polystyrene, See pages 36 and 37								
Polythene, dry	25	ϵ'/ϵ_o	----	----	----	----	----	2.26
		tan δ	----	----	----	----	----	.00067
after 10 days, 90% rel. hum.	25	ϵ'/ϵ_o	----	----	----	----	----	2.26
		tan δ	----	----	----	----	----	.00085

Teflon, dry and after 18 months at 90% relative humidity, 25°C, no change in the range 10^2 to 10^6 c/s.

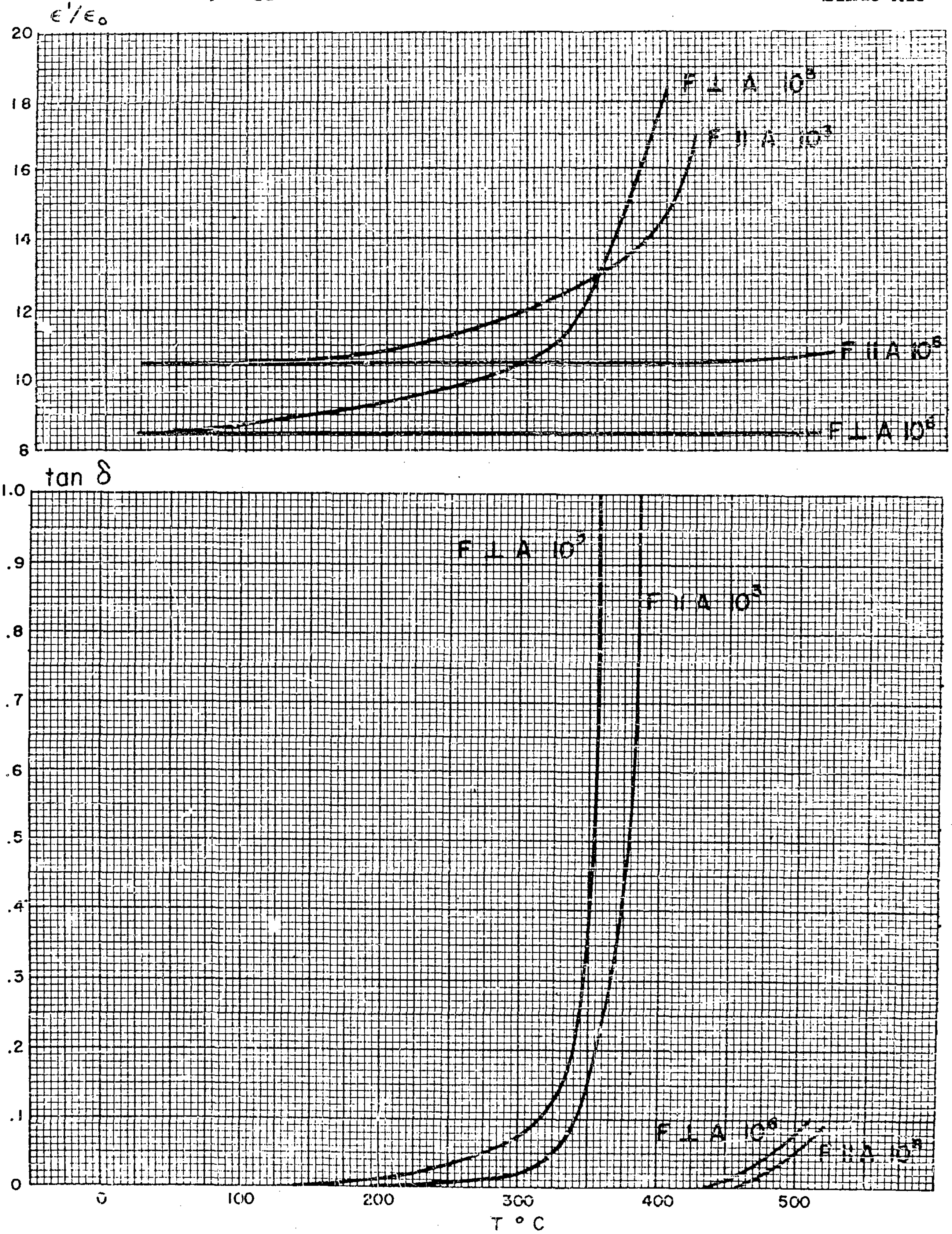
Vinylite VU-1900, dry and after 18 months at 90% relative humidity, 25°C, no change in the range 10^2 to 10^6 c/s.

Data at Fixed Frequency as a Function of Temperature

Inorganic Crystals

Aluminum oxide, sapphire*

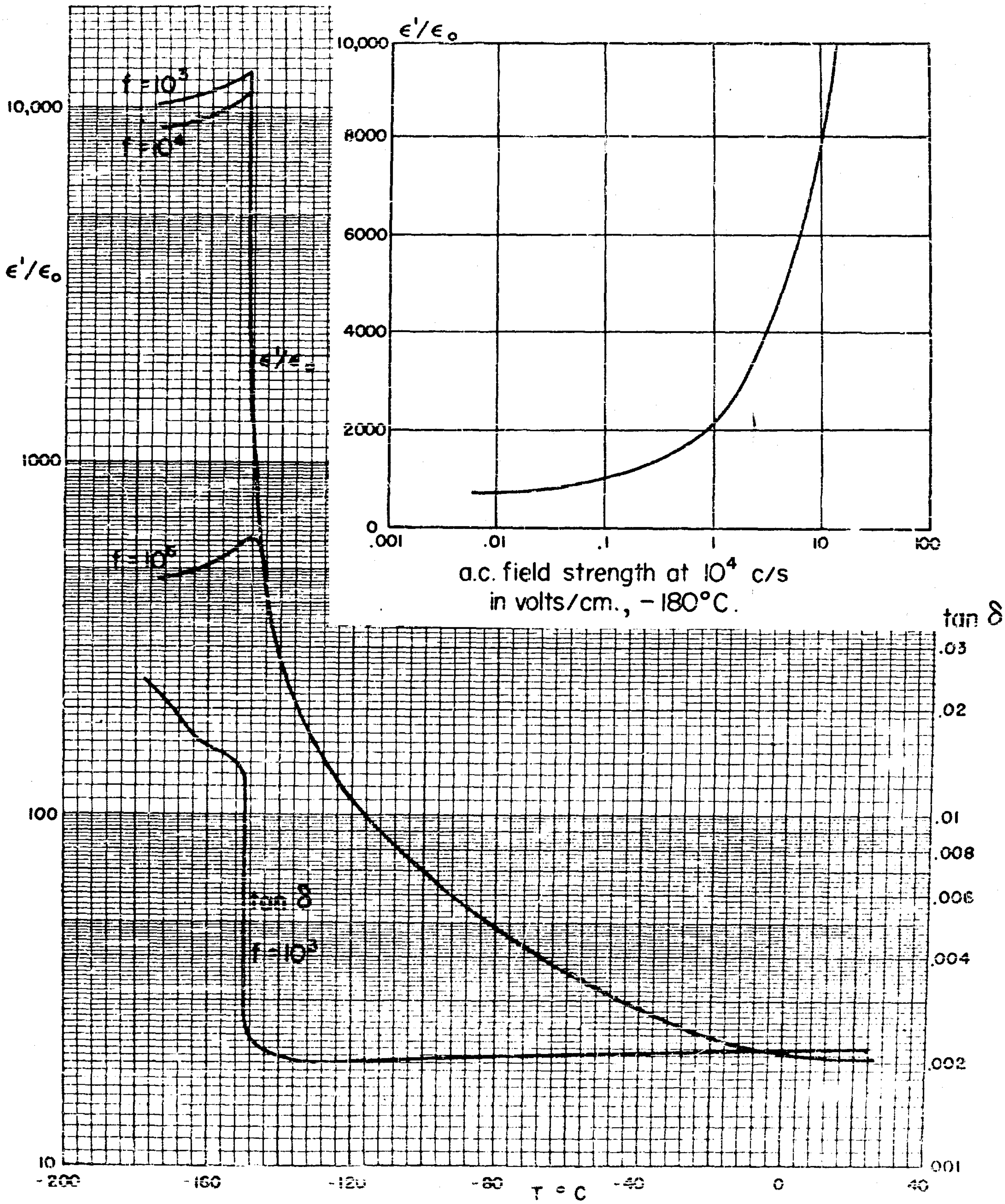
Linde Air



*Field ⊥ to optic axis and field ∥ to optic axis.

Inorganic Crystals (cont.)

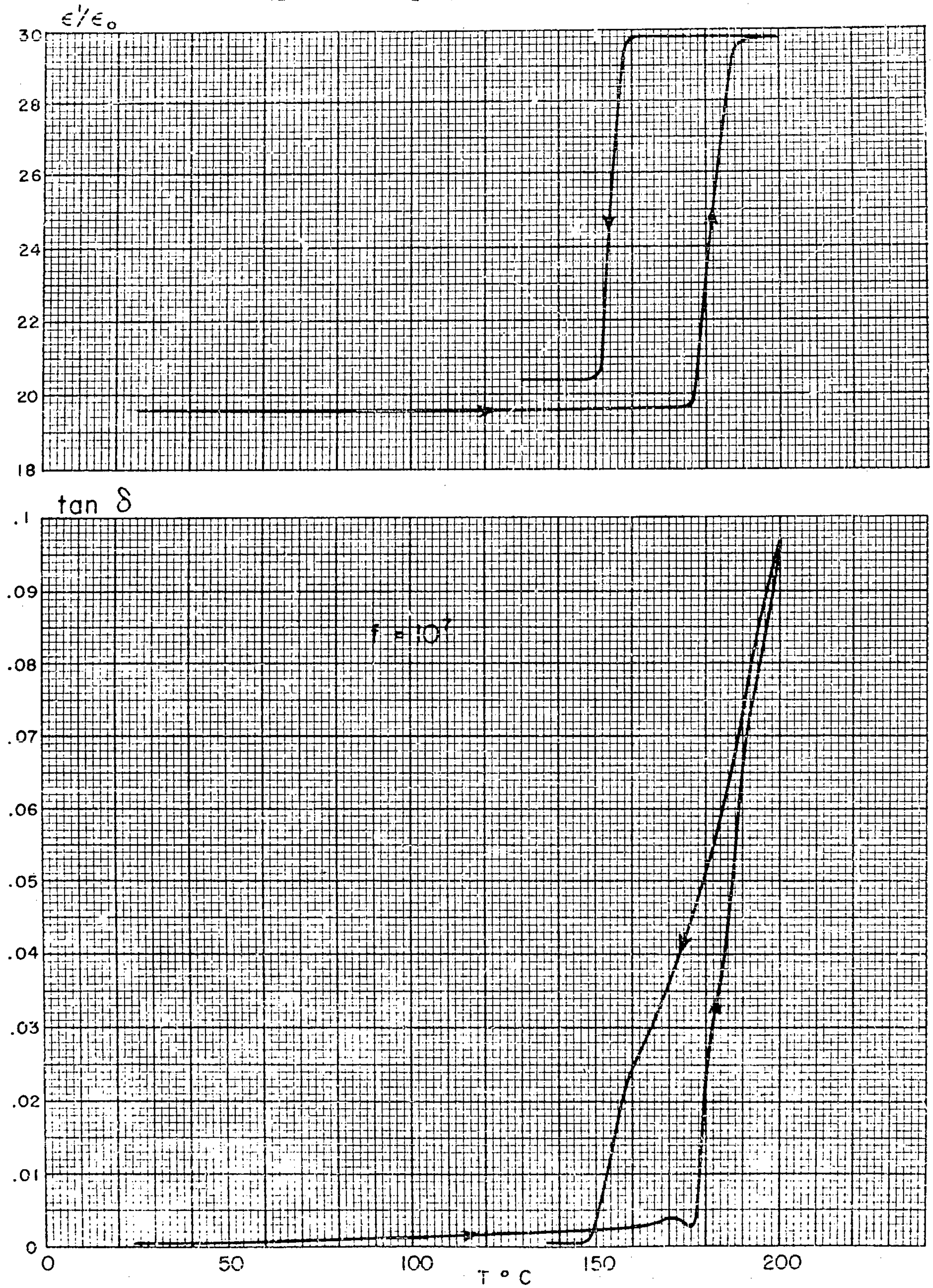
Potassium dihydrogen phosphate* Brush



*Field ∥ to optic axis, 15 volts/cm.

Inorganic Crystals (cont.)

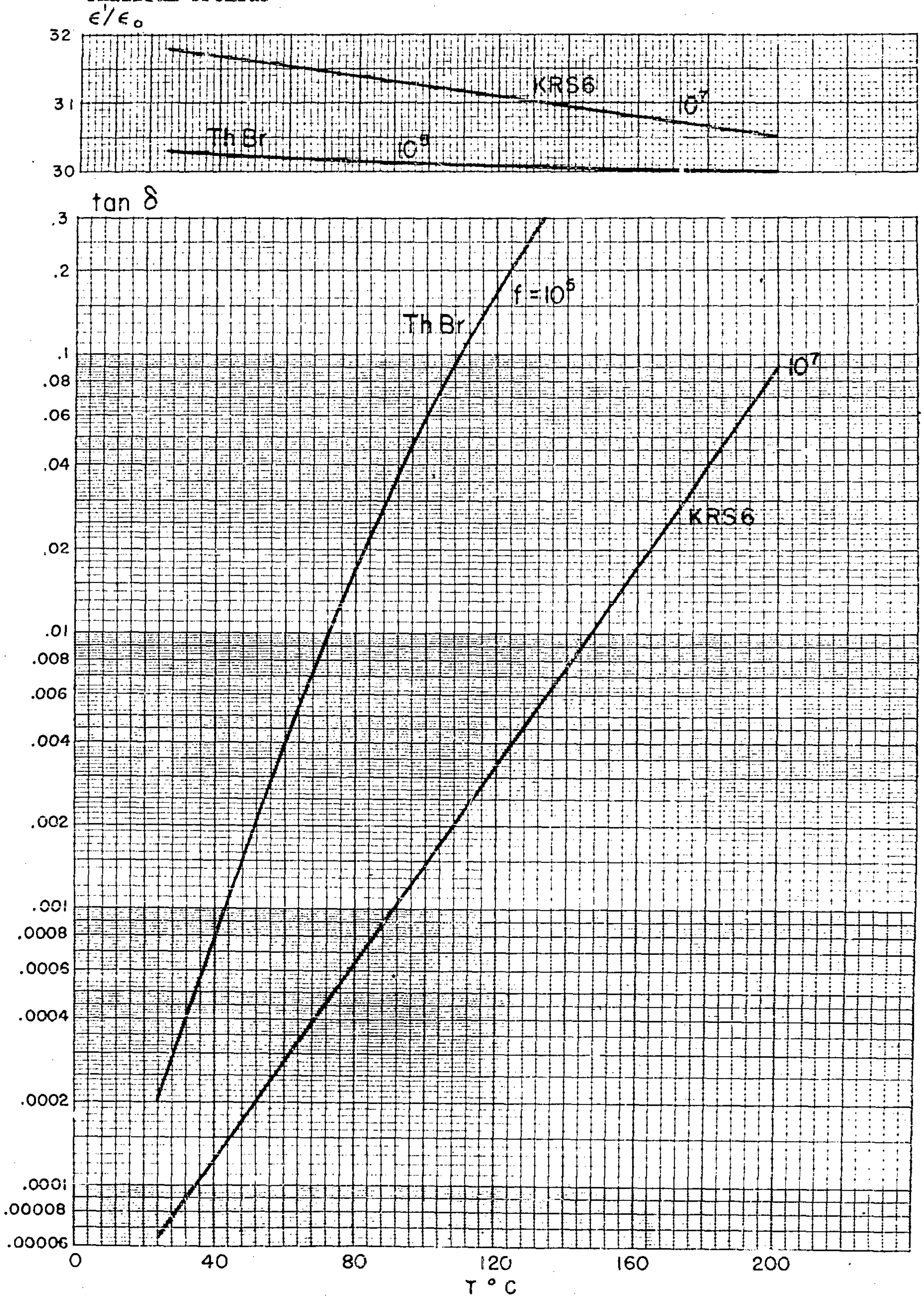
Thallium iodide (pressed sample) Eng. Res. and Dev. Lab.



Inorganic Crystals (cont.)

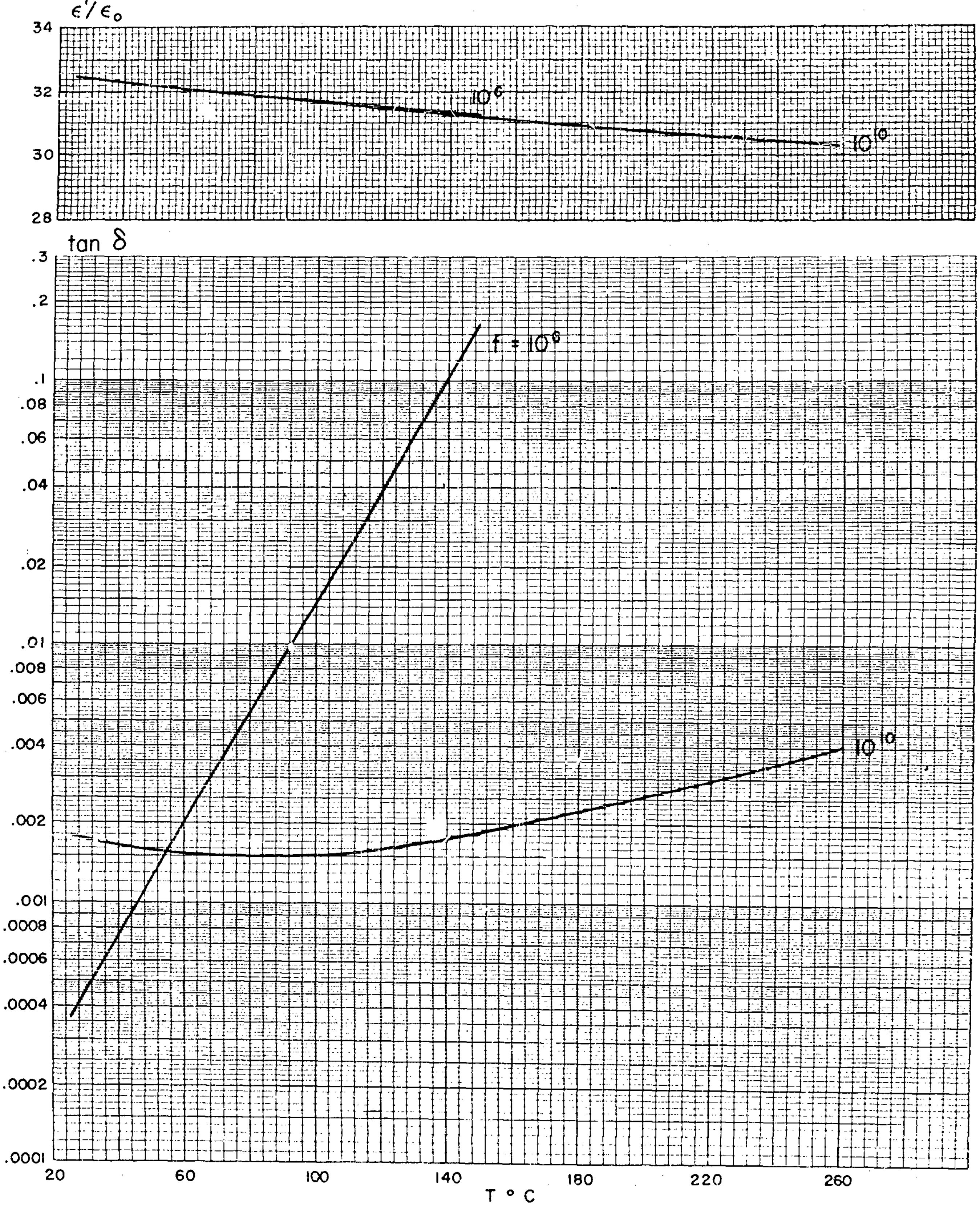
KRS-6 (ThCl, 40%, ThBr, 60%)
Thallium bromide

Eng. Res. and Dev. Lab.



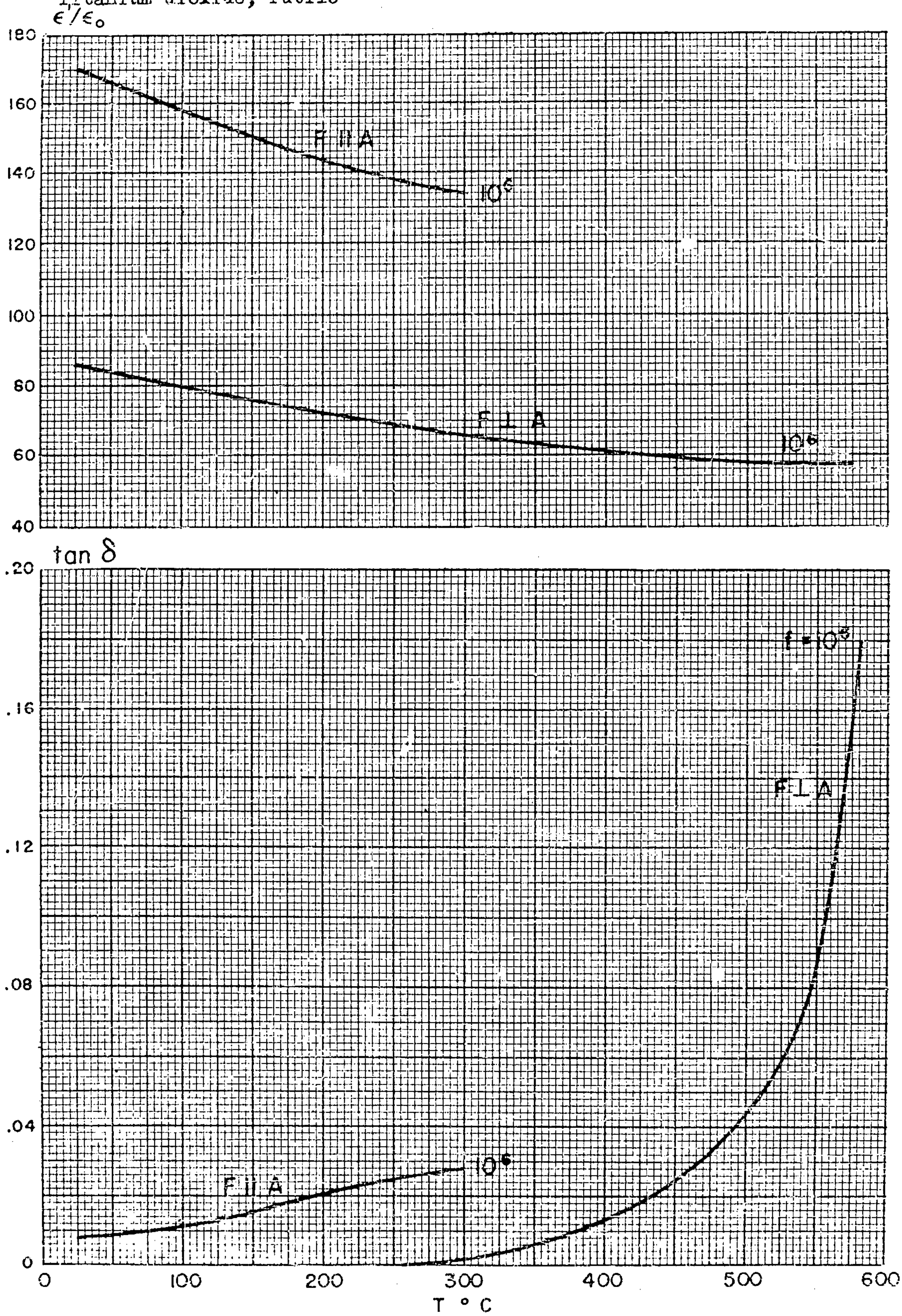
Inorganic Crystals (cont.)

KRS-5 (TlBr, 42%, TlI, 58%) Eng. Res. and Dev. Lab.



Inorganic Crystals (cont.)

Titanium dioxide, rutile* | Linde Air

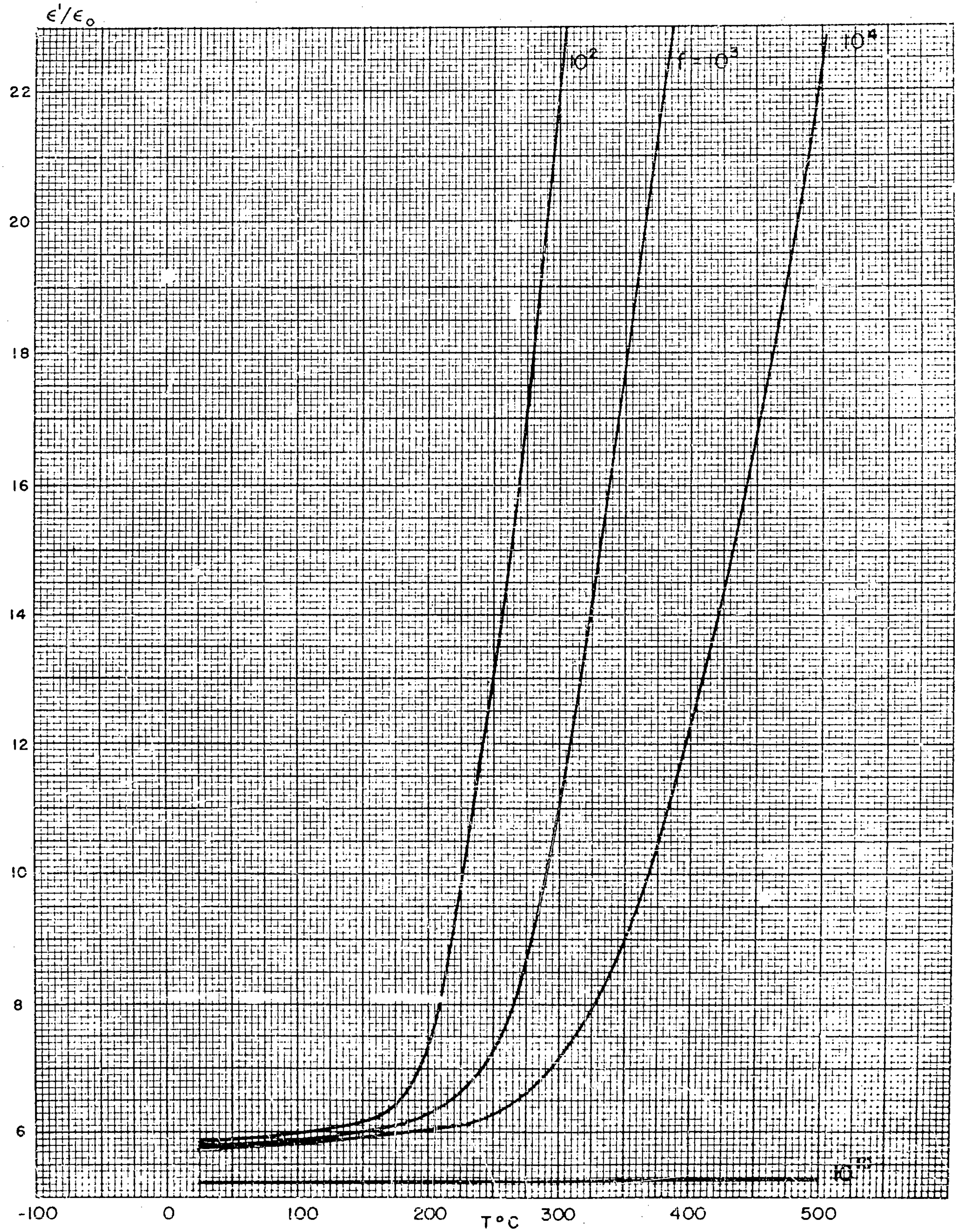


*Field ⊥ to optic axis and field ∥ to optic axis.

Steatite Bodies

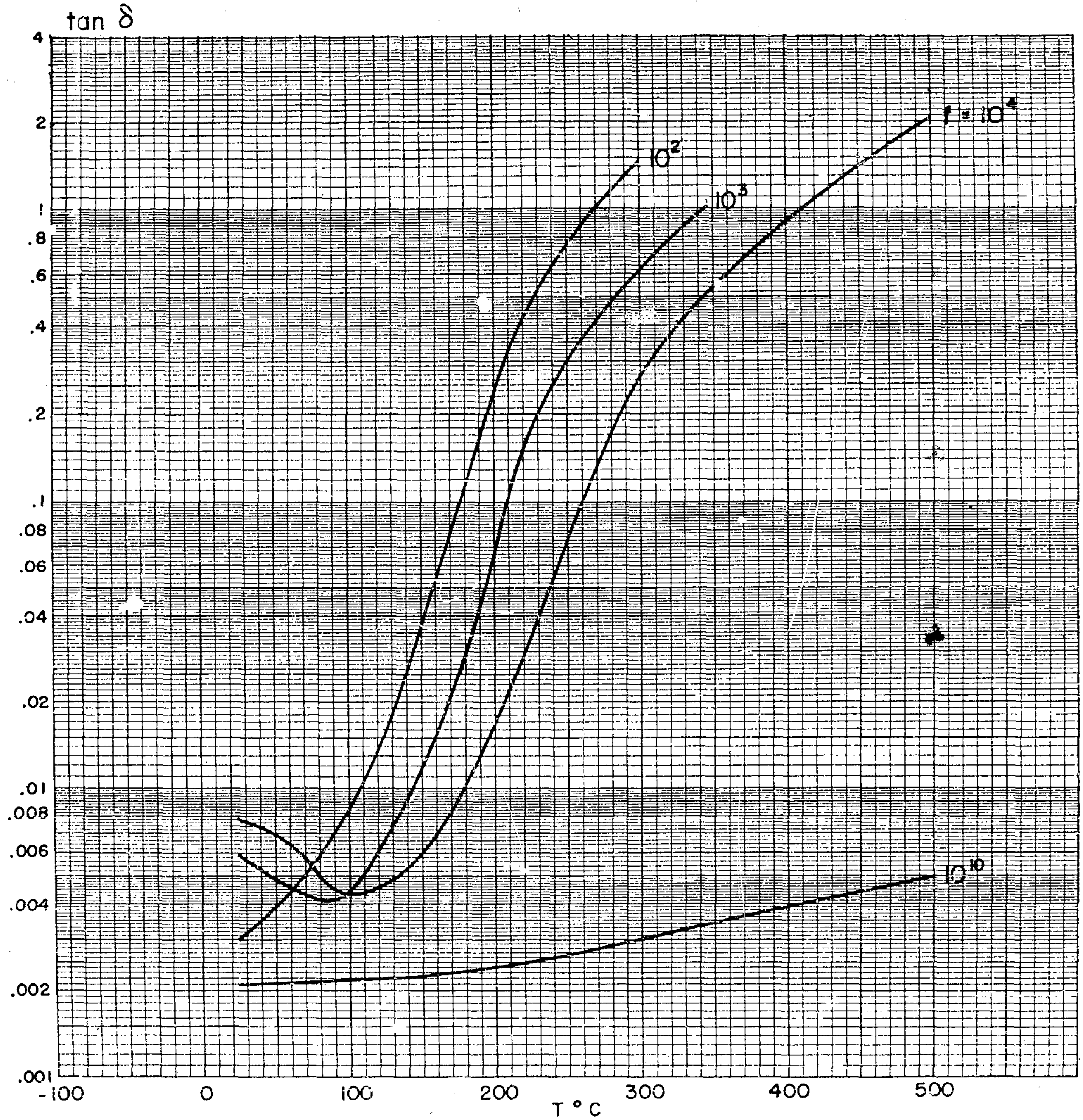
AlSiMag A-196

Amer. Lava



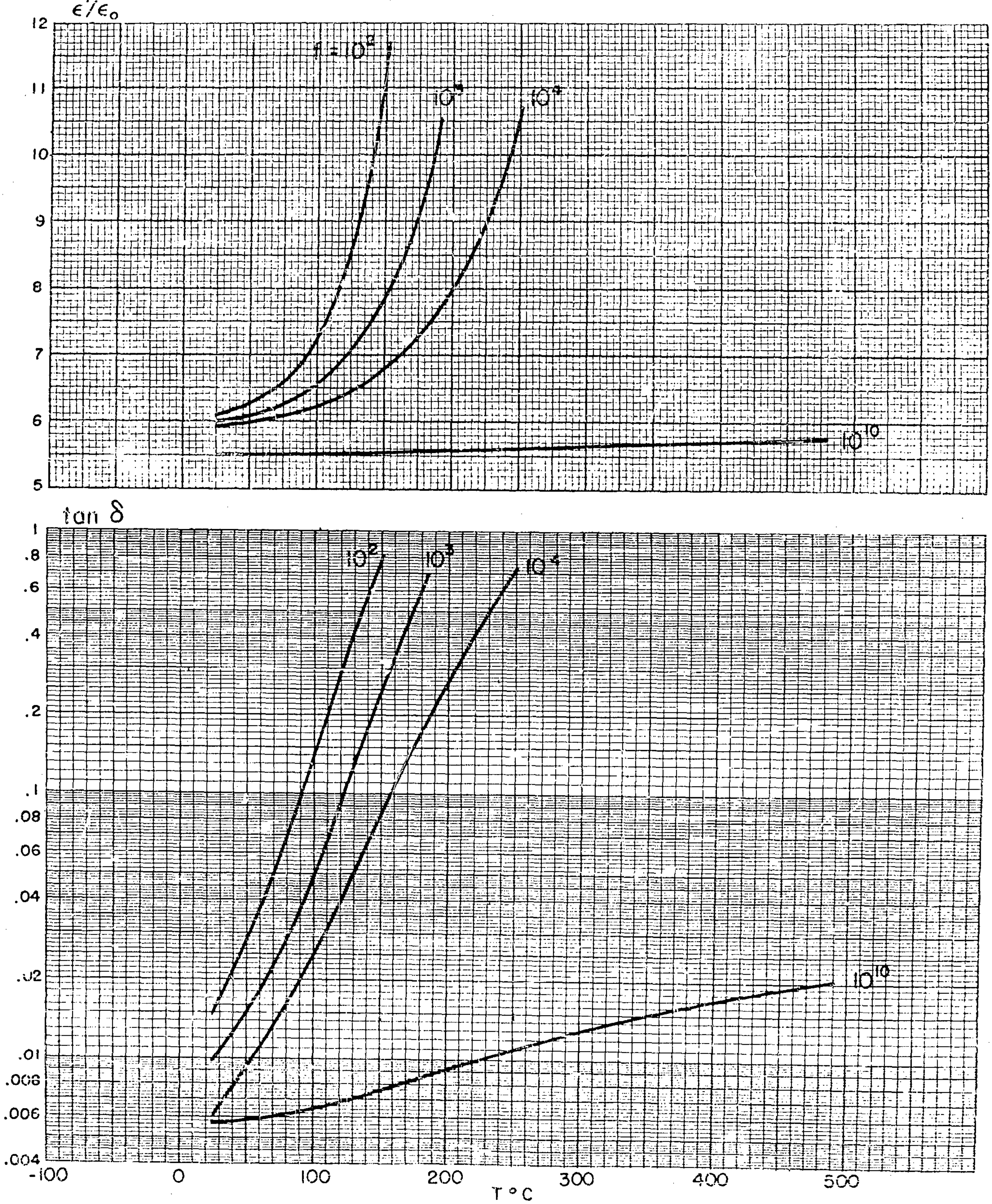
Steatite Bodies (cont.)

AlSiMag A-196	Amer. Lava



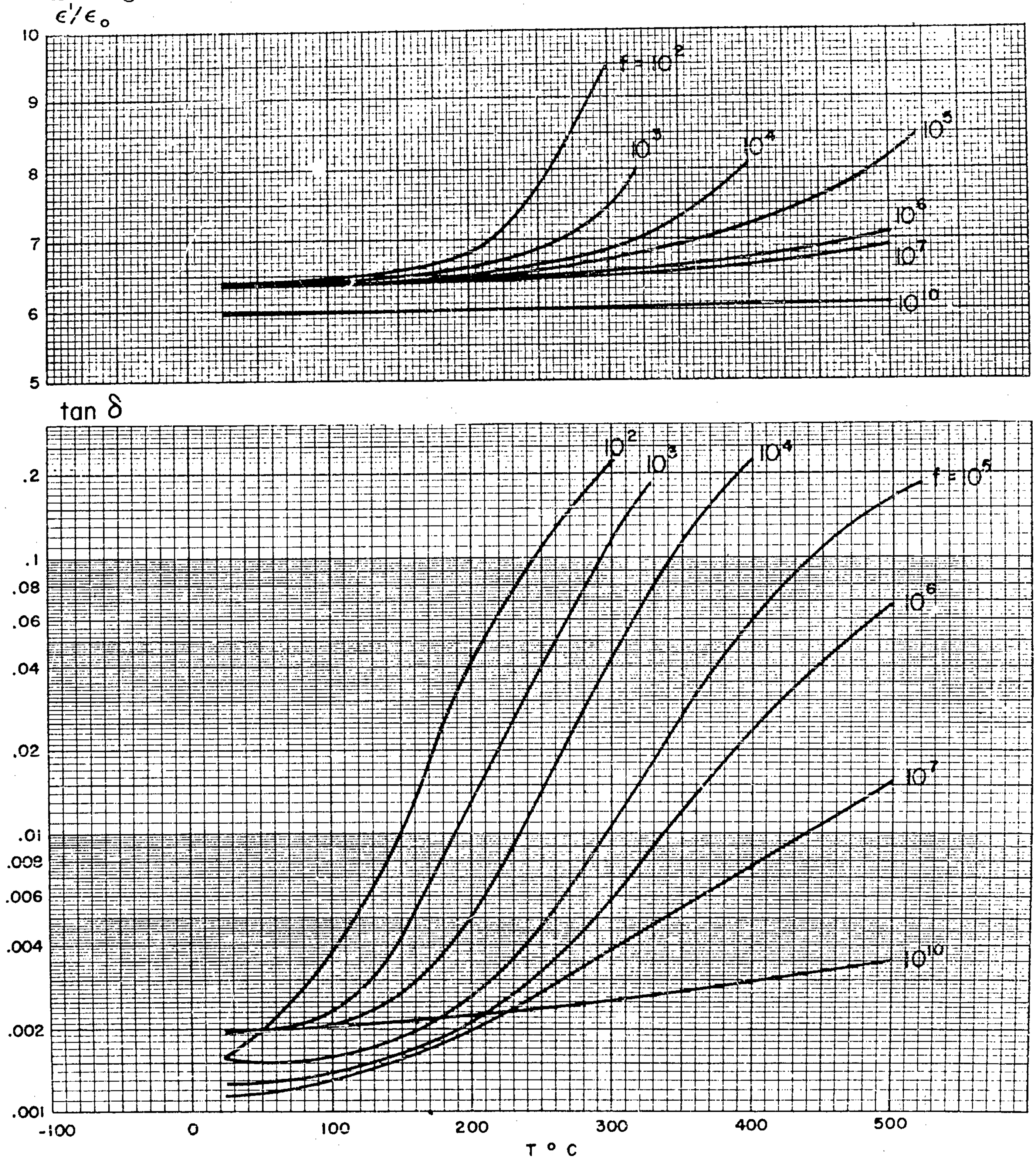
Steatite Bodies (cont.)

AlSiMag A-35 Amer. Lava



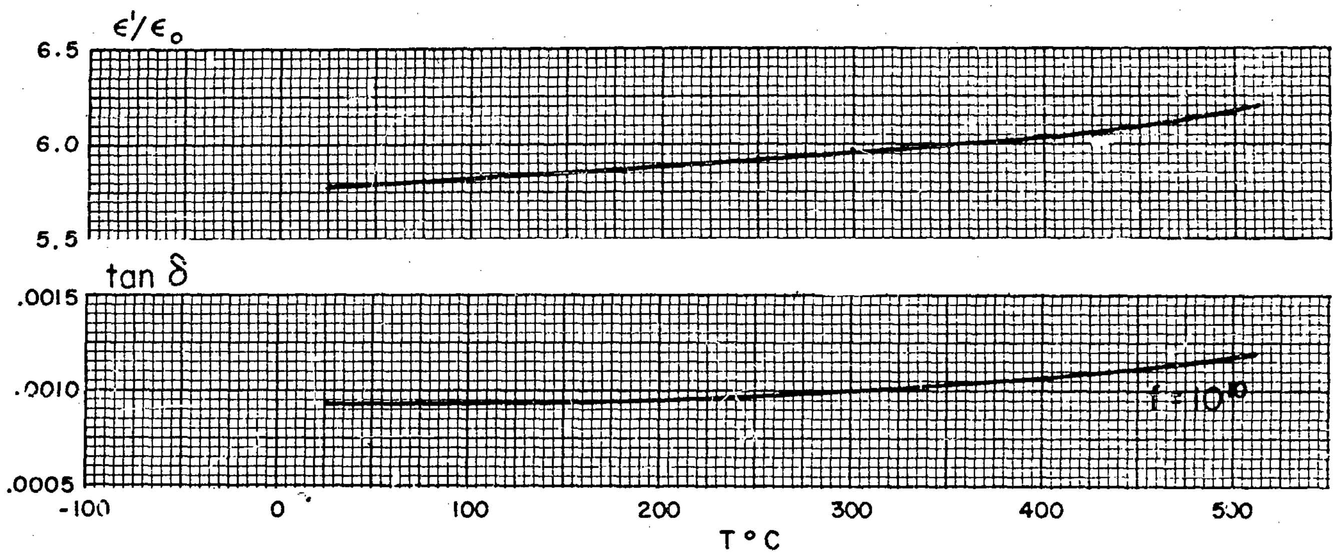
Steatite Bodies (cont.)

AlSiMag 228 Amer. Lava

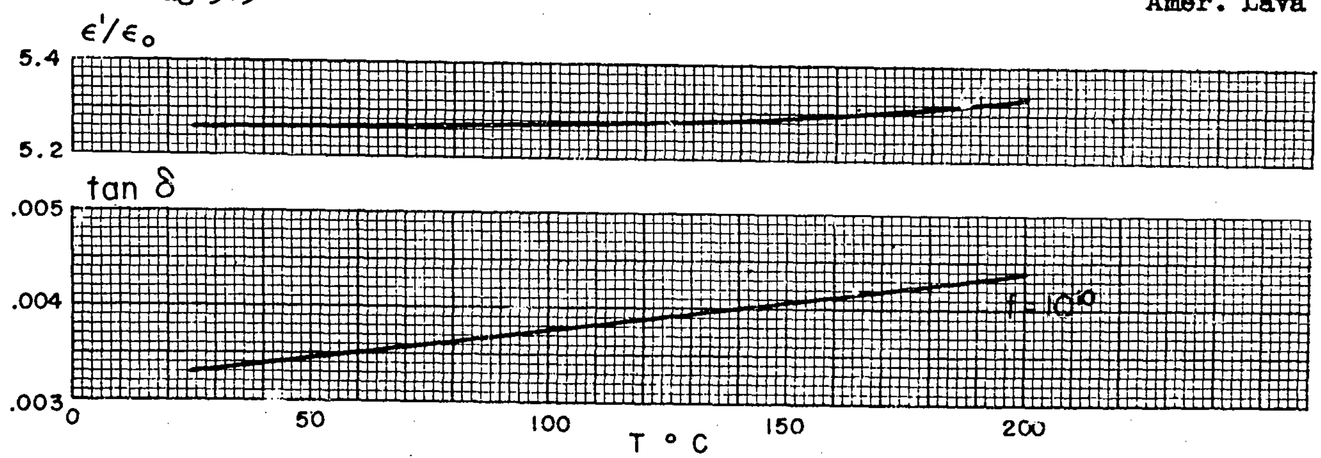


Steatite Bodies (cont.)

AlSiMag 243 Amer. Lava

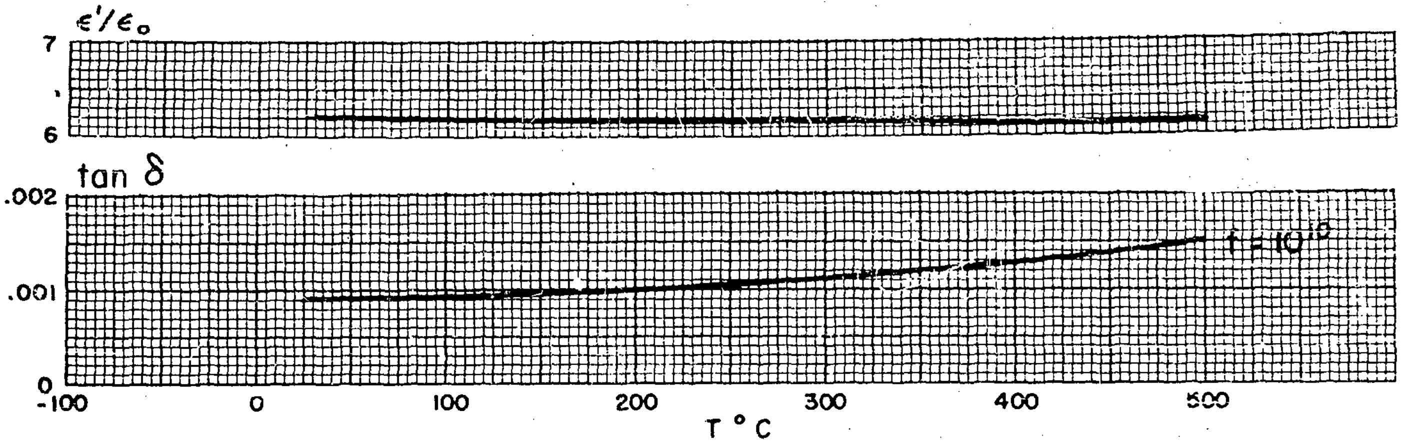


AlSiMag 505 Amer. Lava

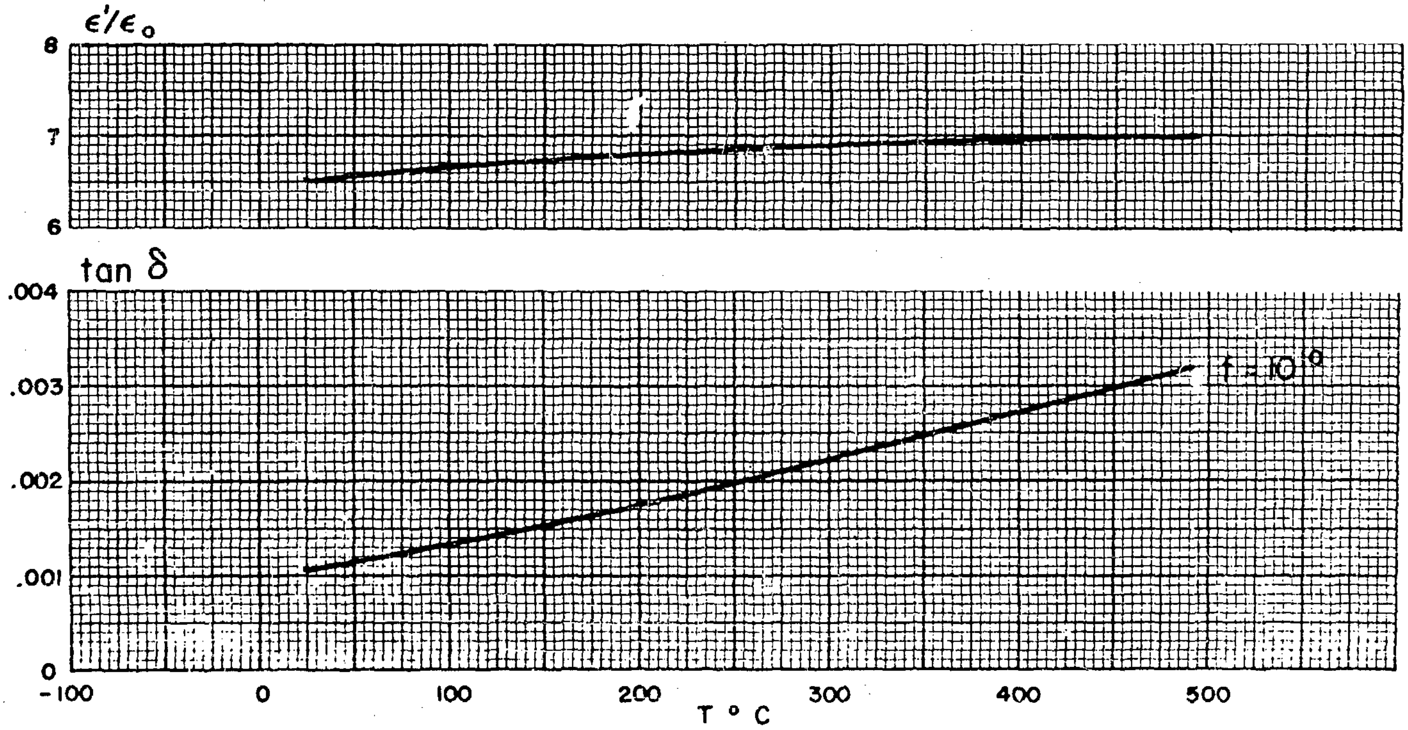


Steatite Bodies (cont.)

Ceramic F-66 Bell

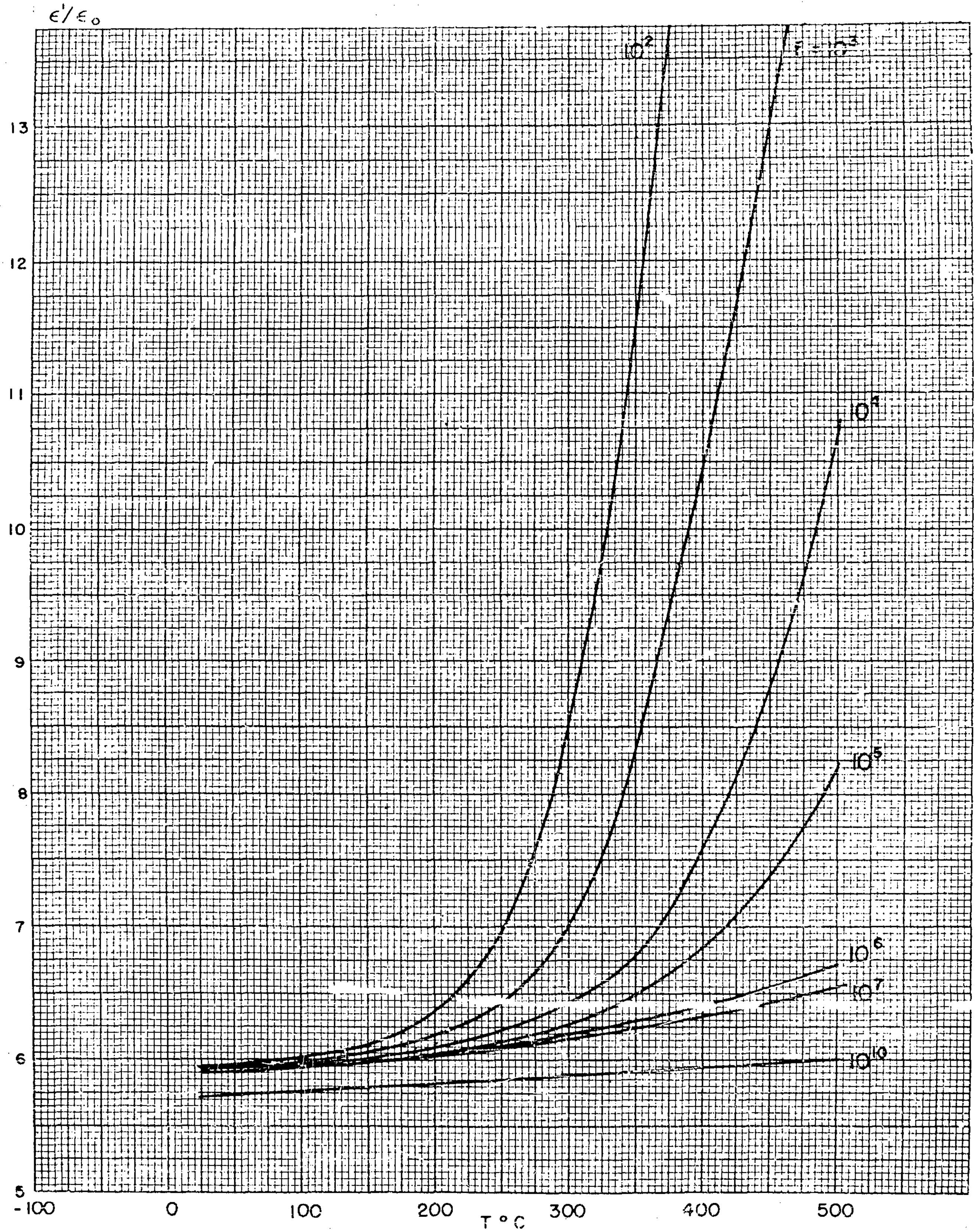


Steatite Body 7292 Gen. Ceramics and Steatite



Steatite Bodies (cont.)

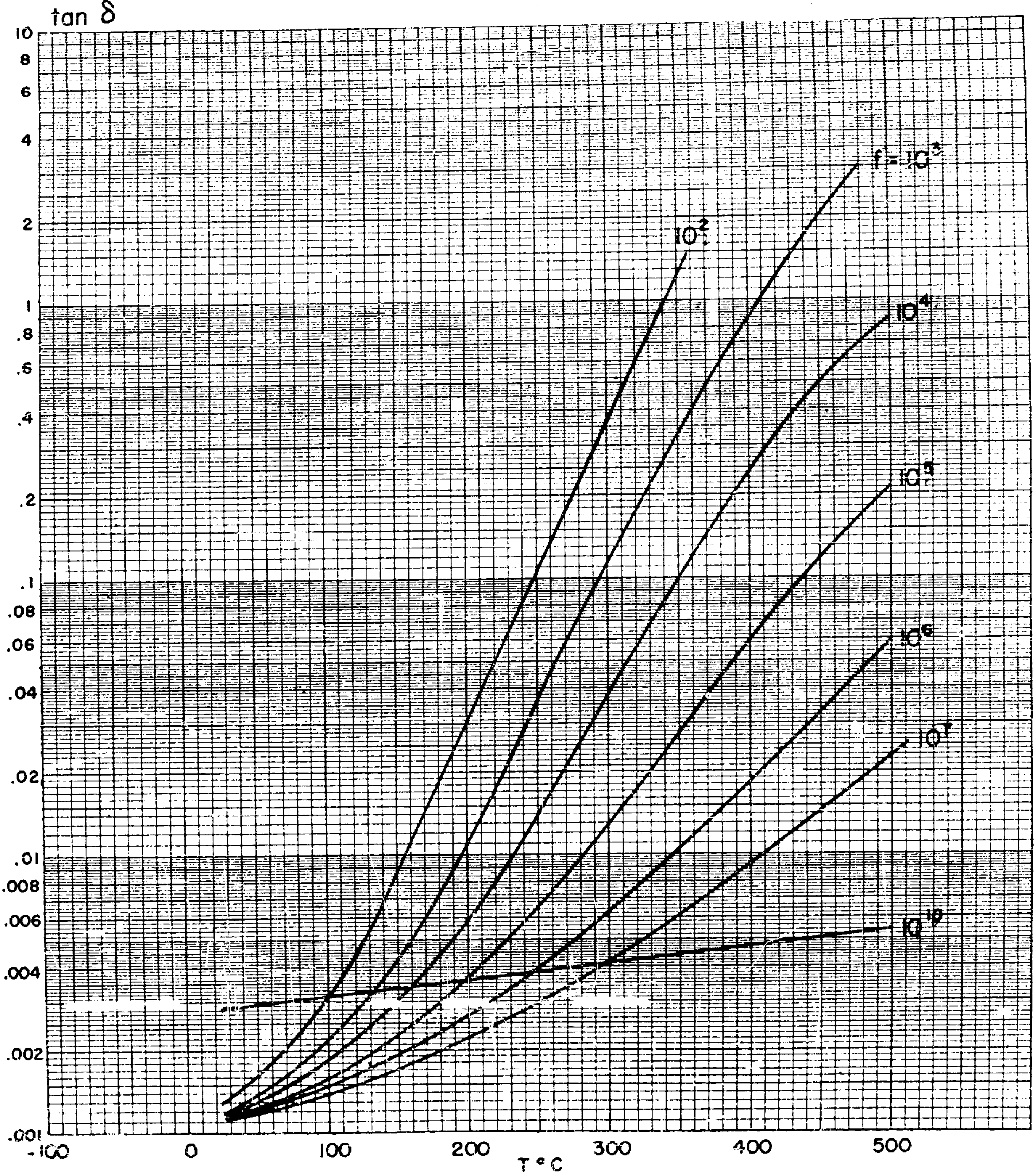
Steatite Type 302 Centralab



Steatite Bodies (cont.)

Centralab

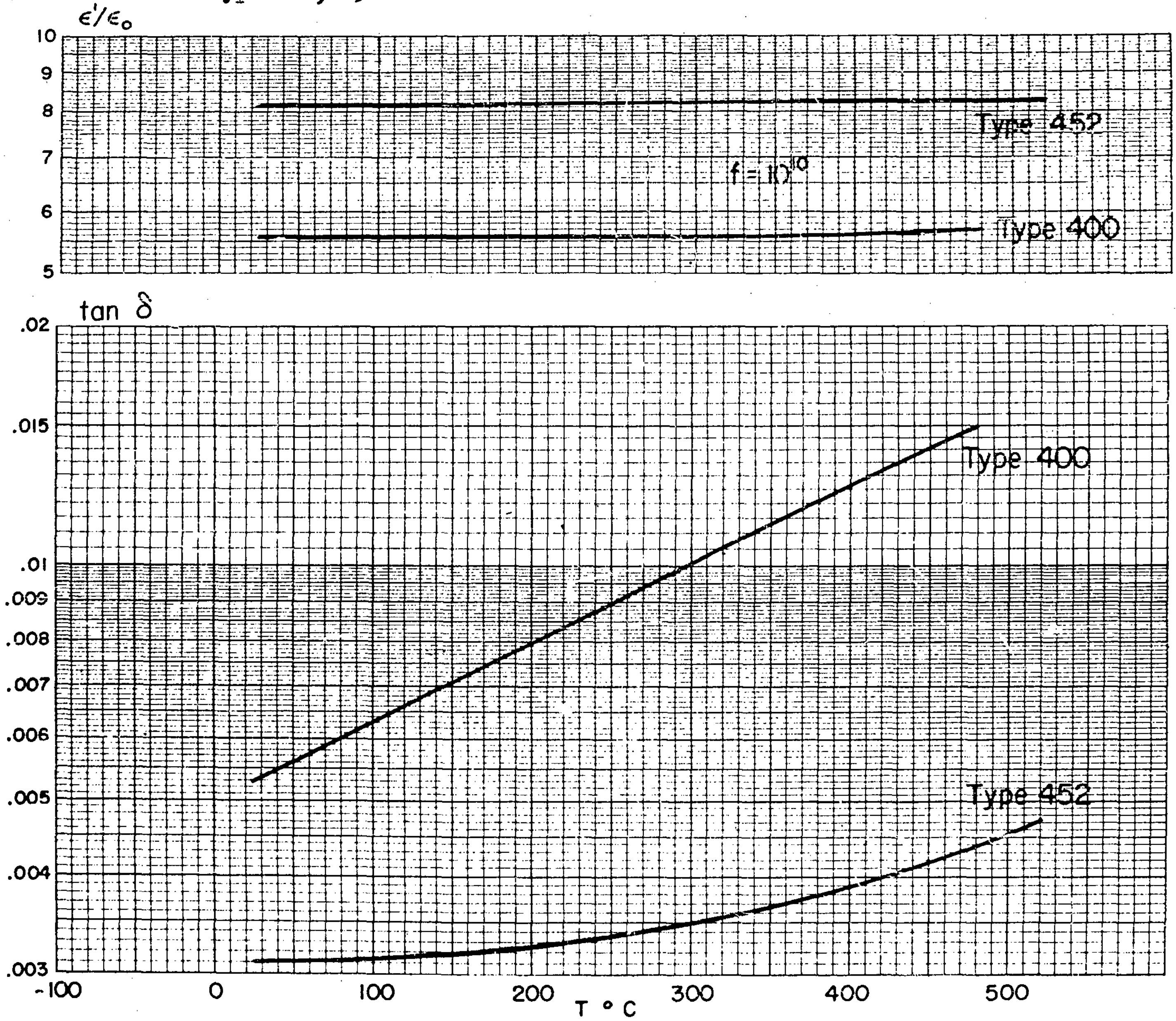
Steatite Type 302



Steatite Bodies (cont.)

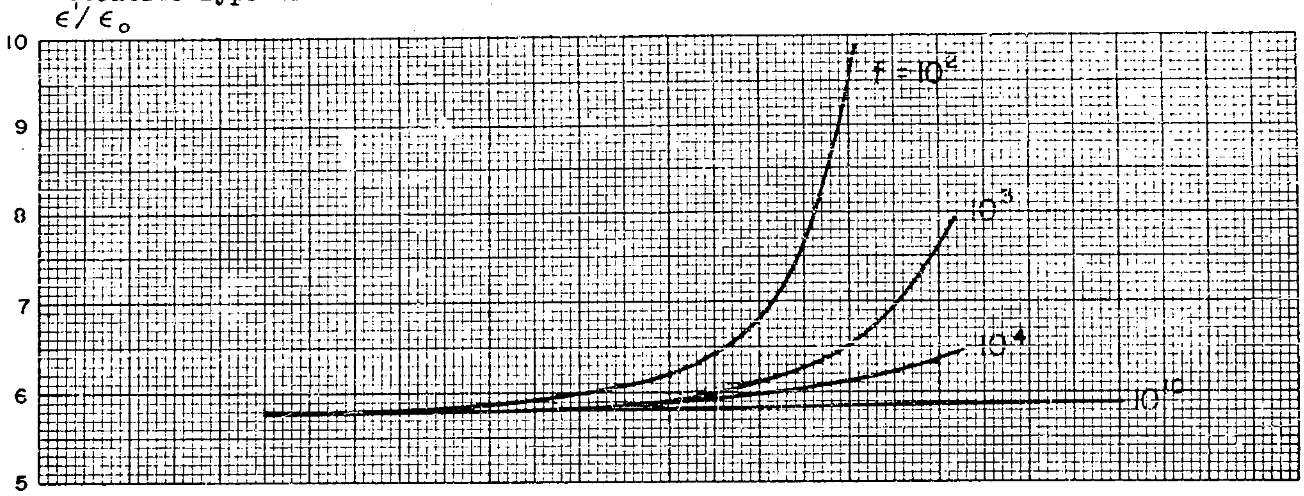
Steatite Type 400, 452

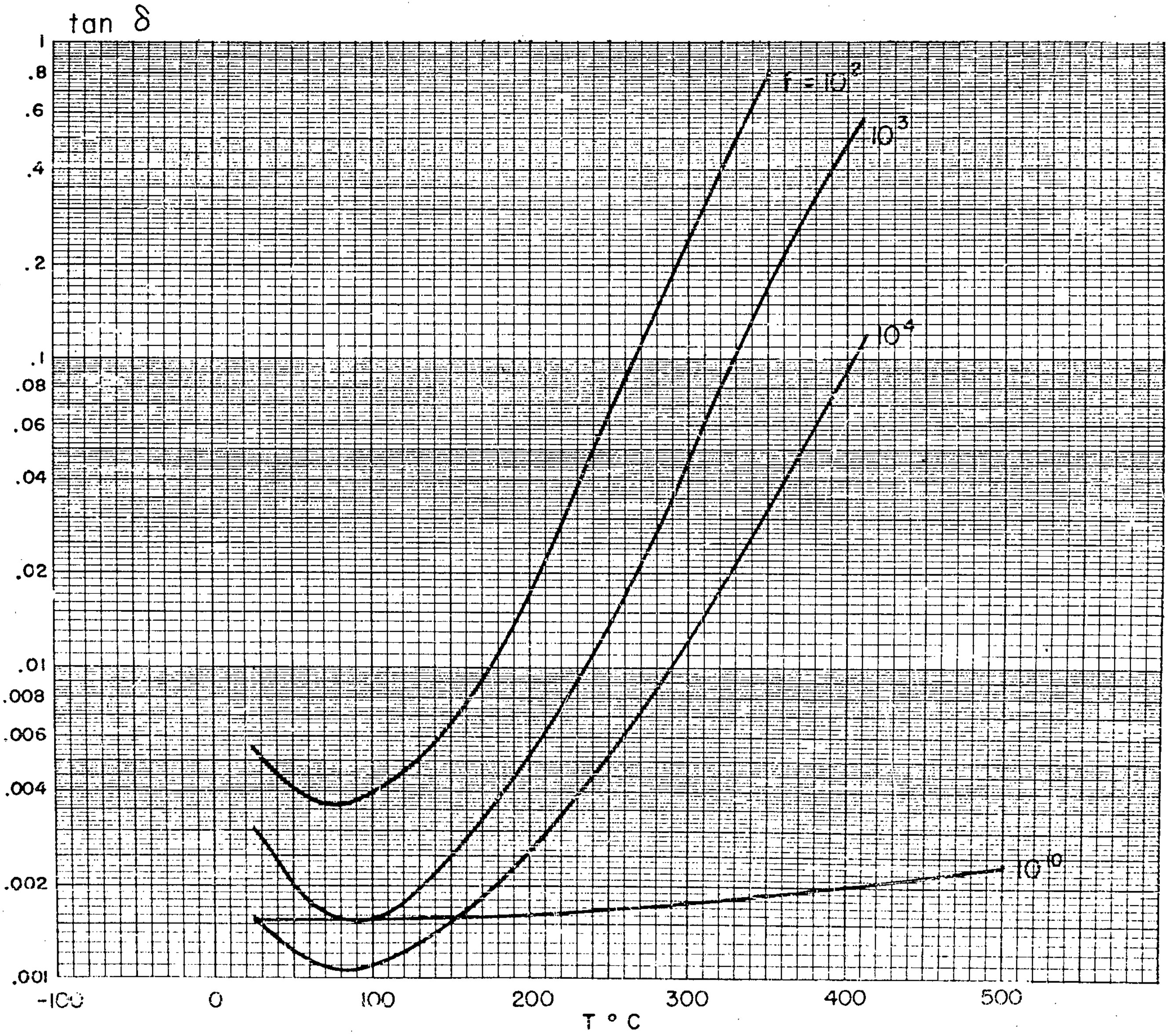
Centralab



Steatite Bodies (cont.)

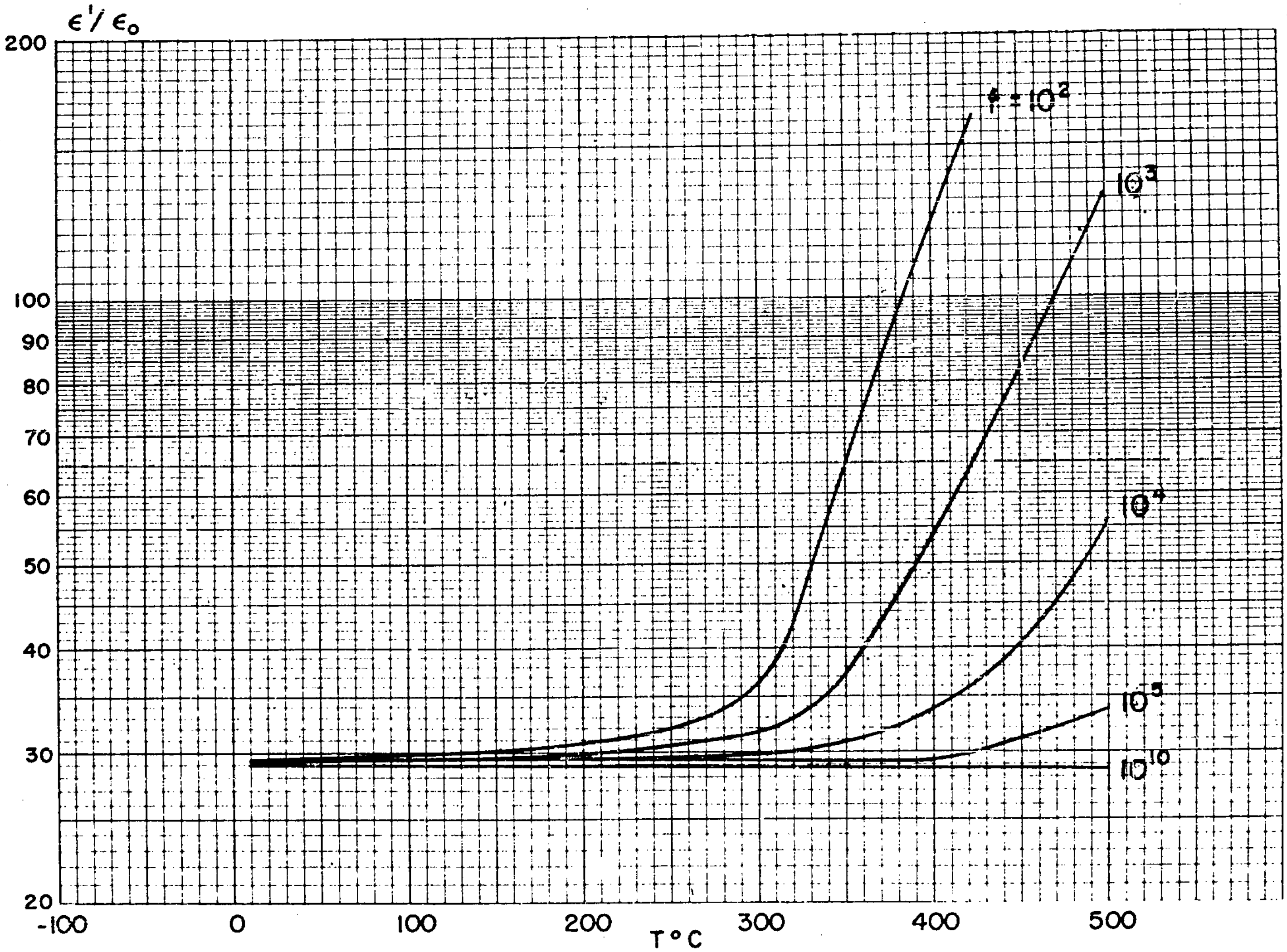
Steatite Type 410 Centralab





Titania and Titanate Bodies

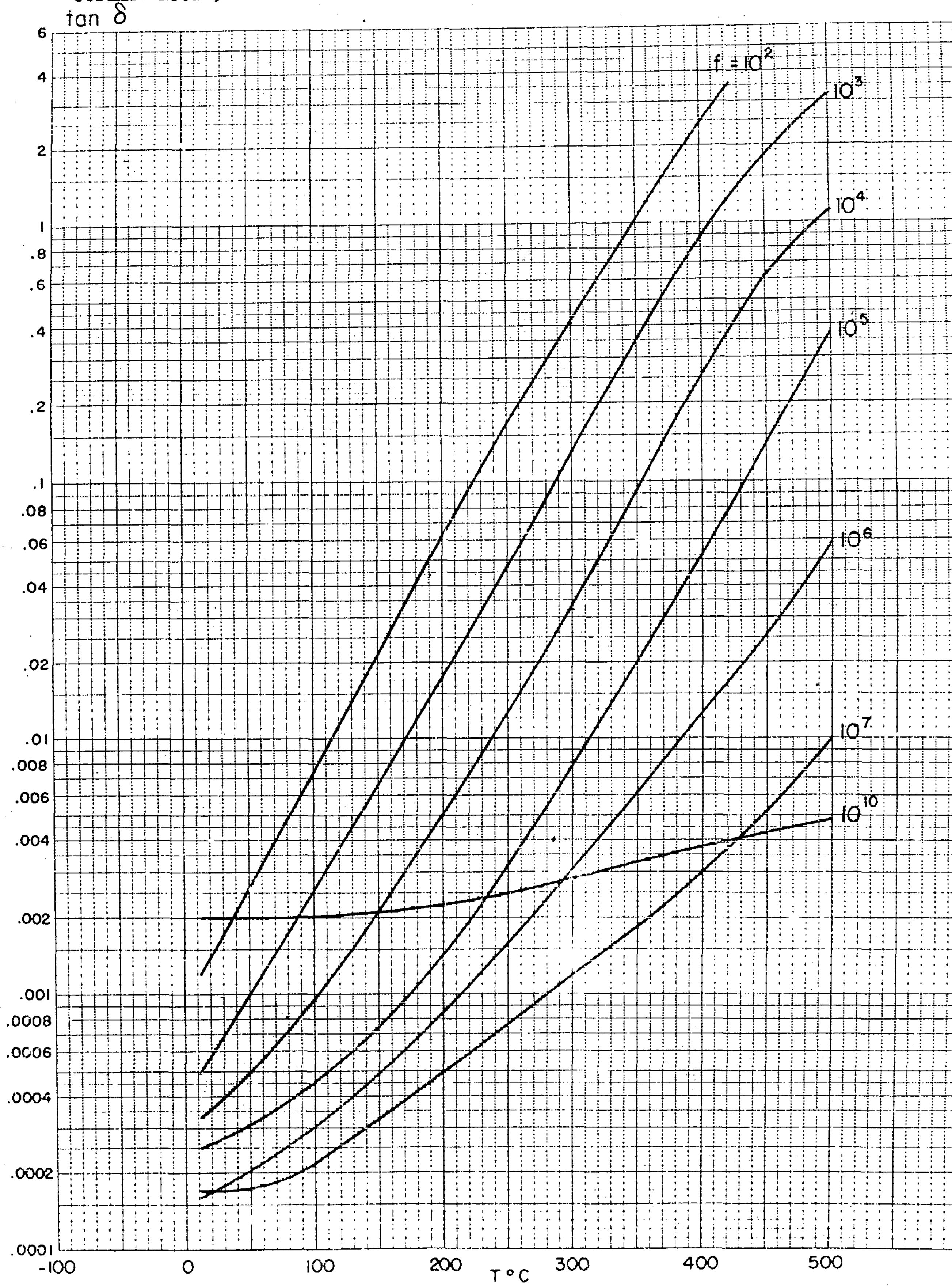
Ceramic NPOT 96 Amer. Lava



Titania and Titanate Bodies (cont.)

Ceramic NPOT 96

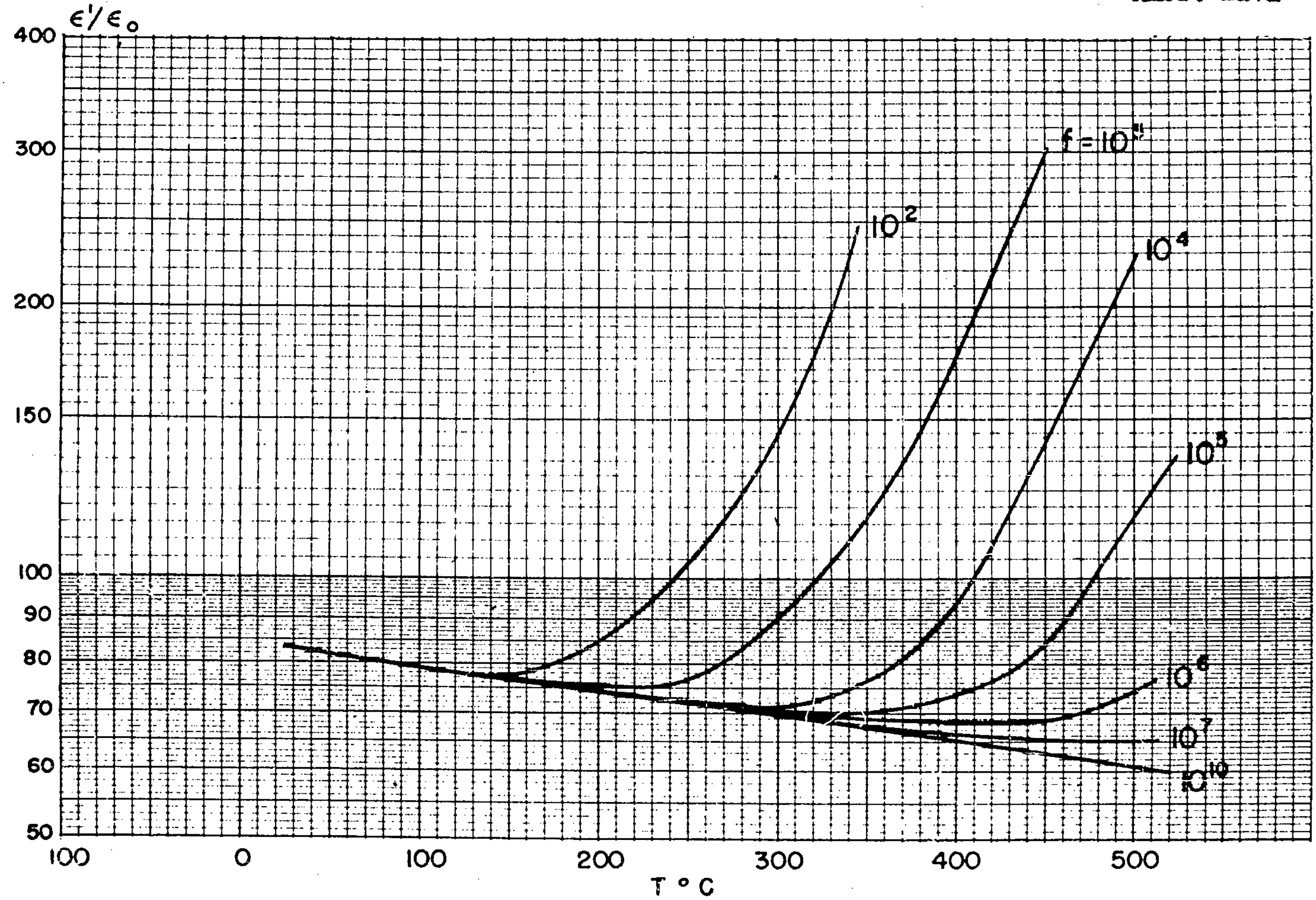
Amer. Lava



Titania and Titanate Bodies (cont.)

Ceramic N750T96

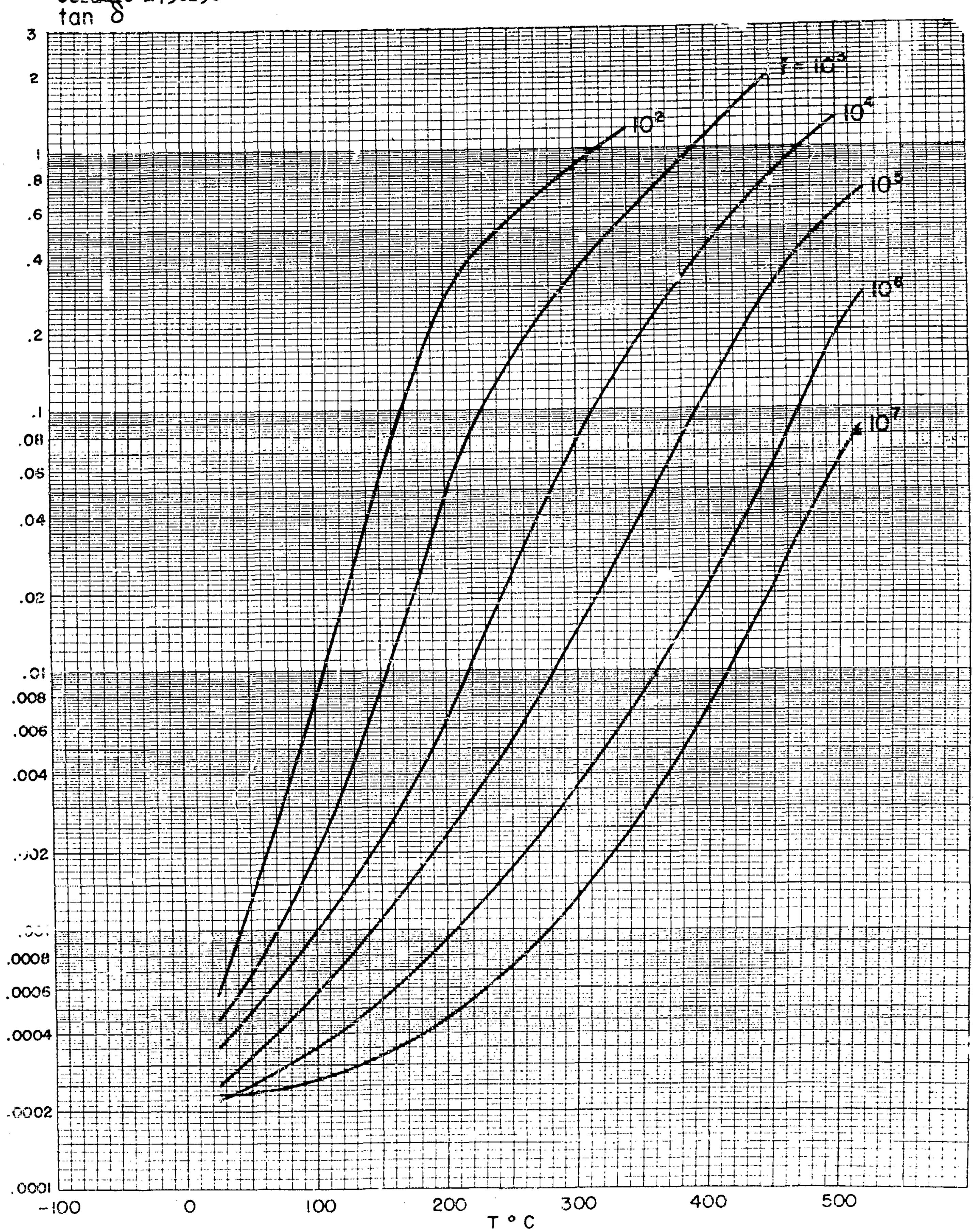
Amer. Lava



Titania and Titanate Bodies (cont.)

Amer. Lava

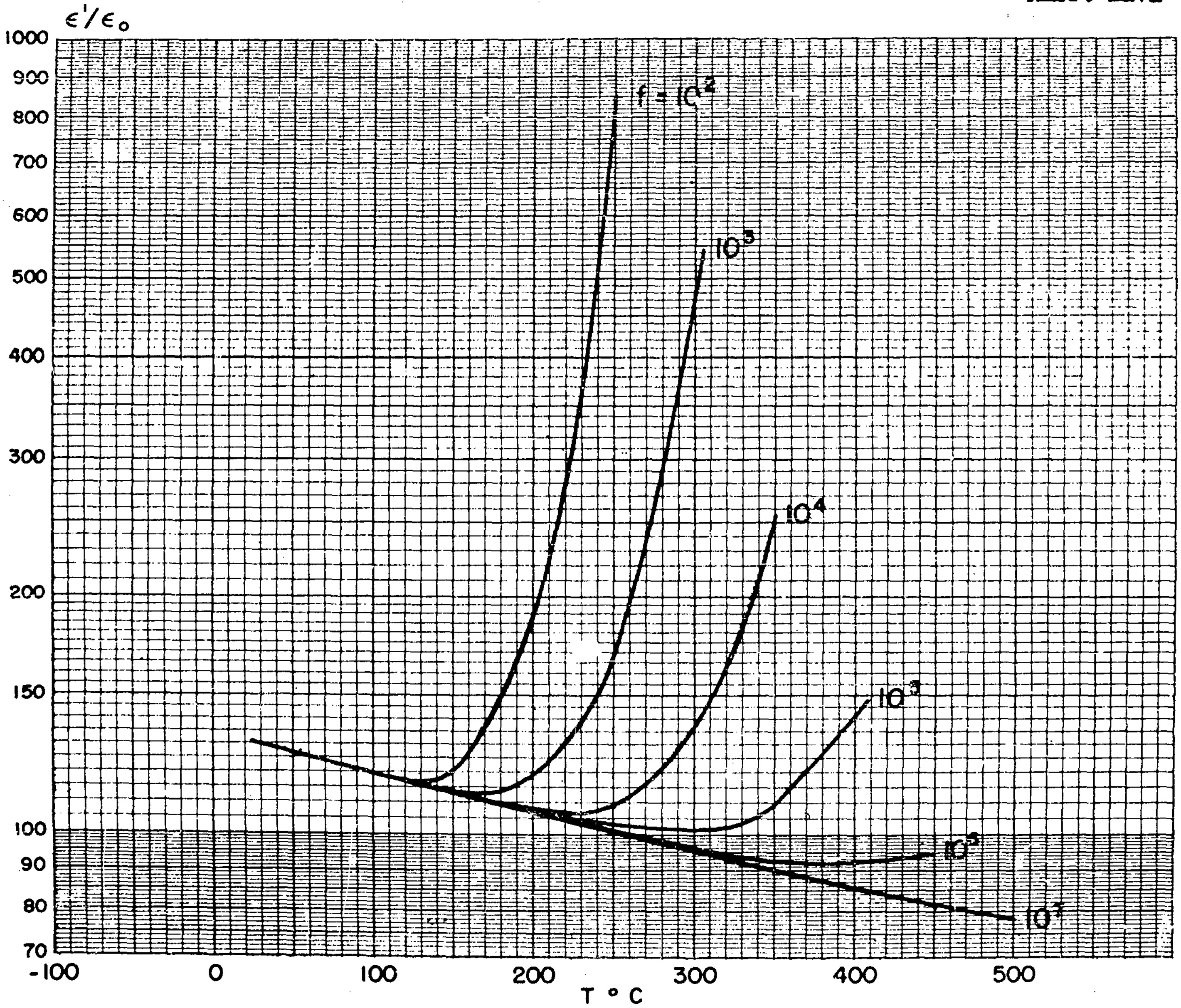
Ceramic N750T96



Titania and Titanate Bodies (cont.)

Ceramic N1400T110

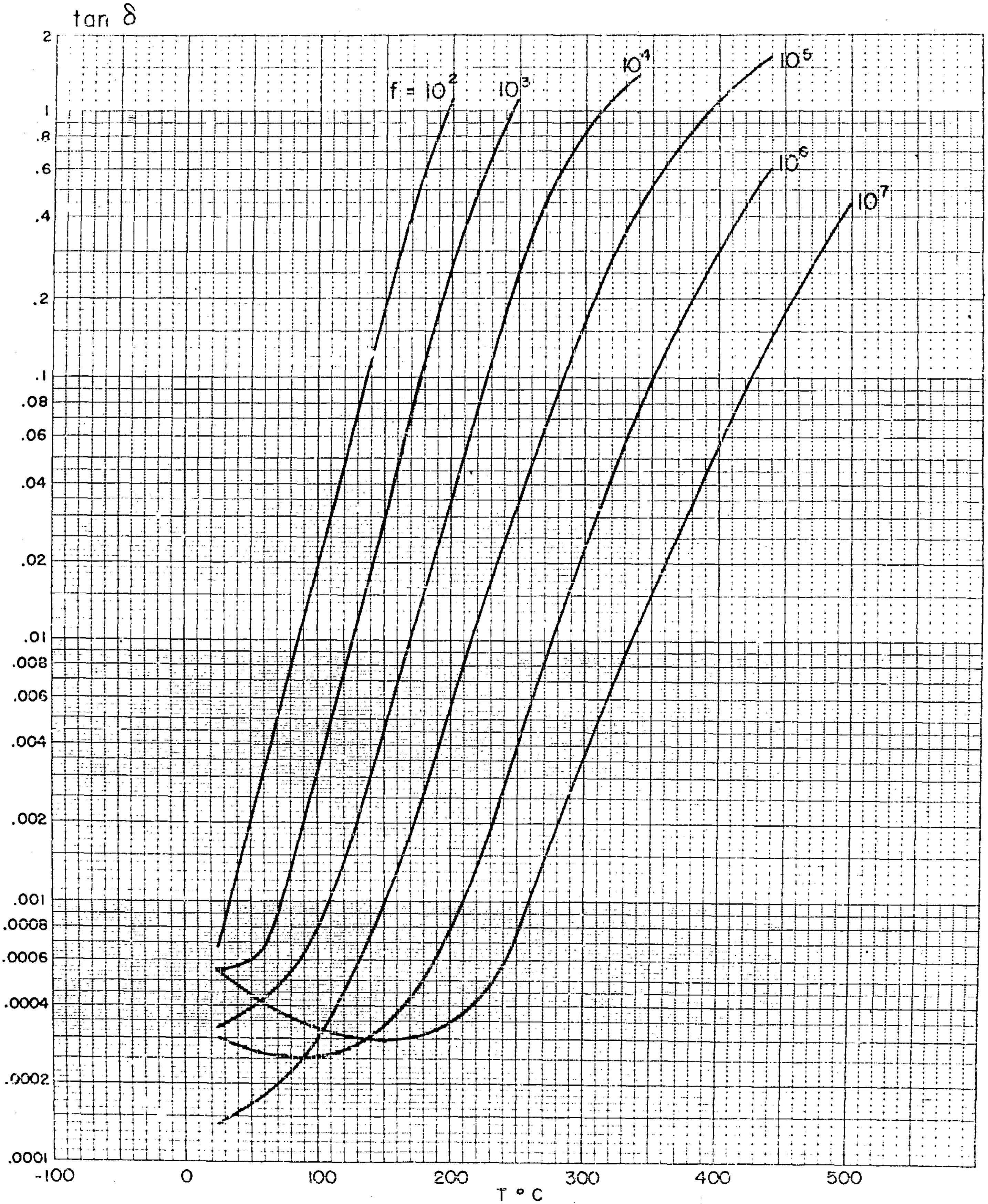
Amer. Lava



Titania and Titanate Bodies (cont.)

Ceramic N1400T110

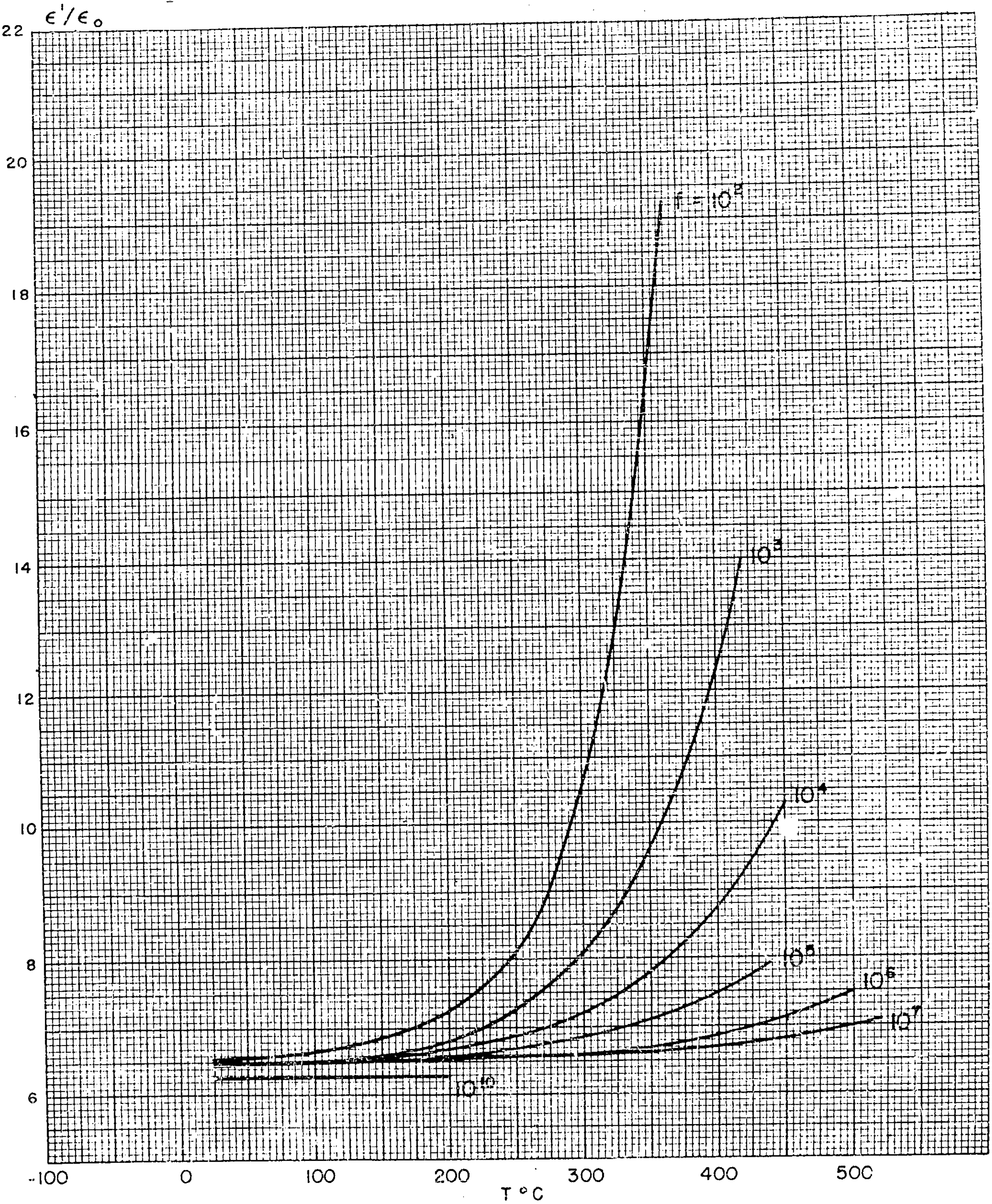
Amer. Lava



Porcelains

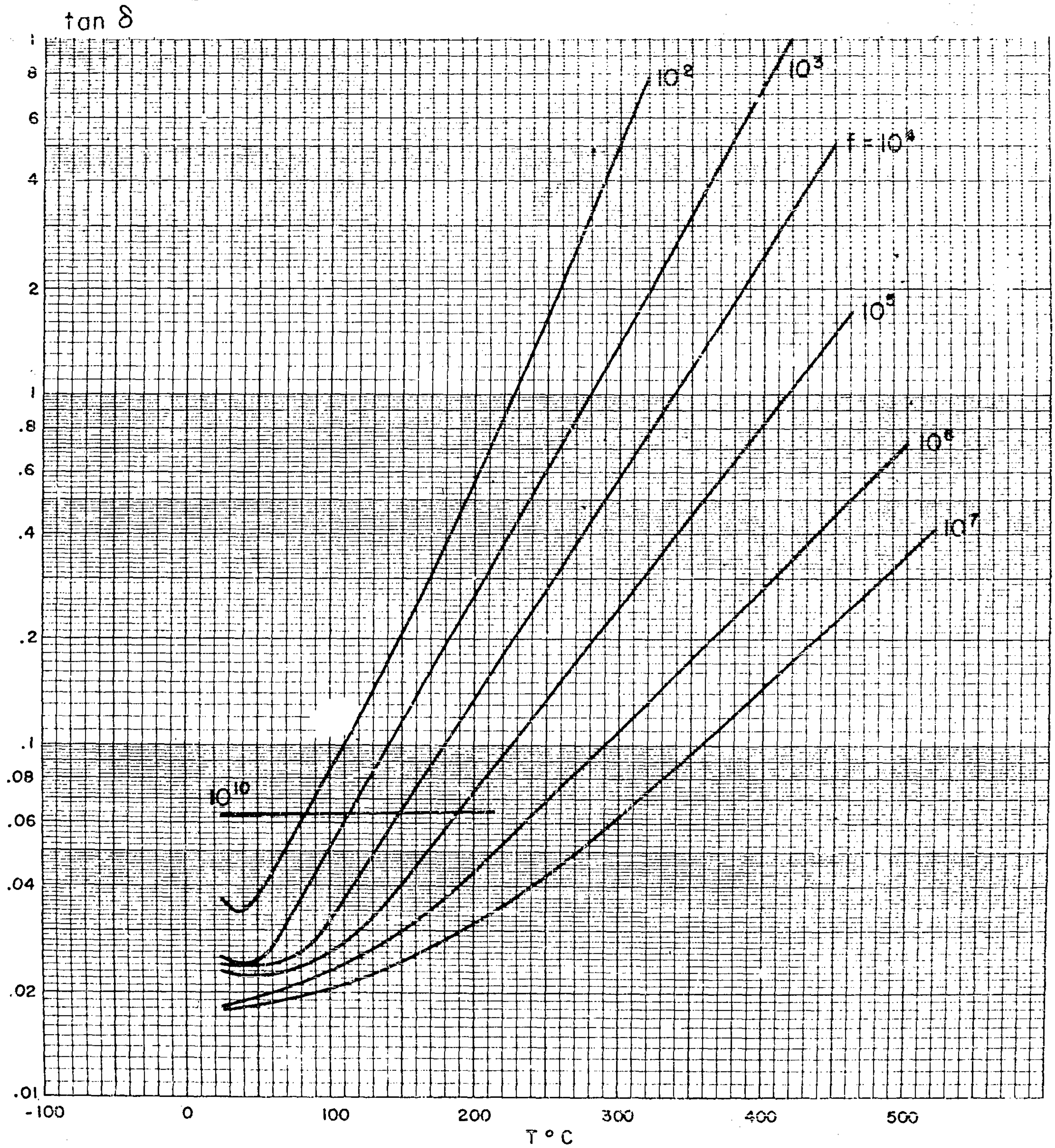
Zirconium porcelain Zi-4

Coors



Porcelains (cont.)

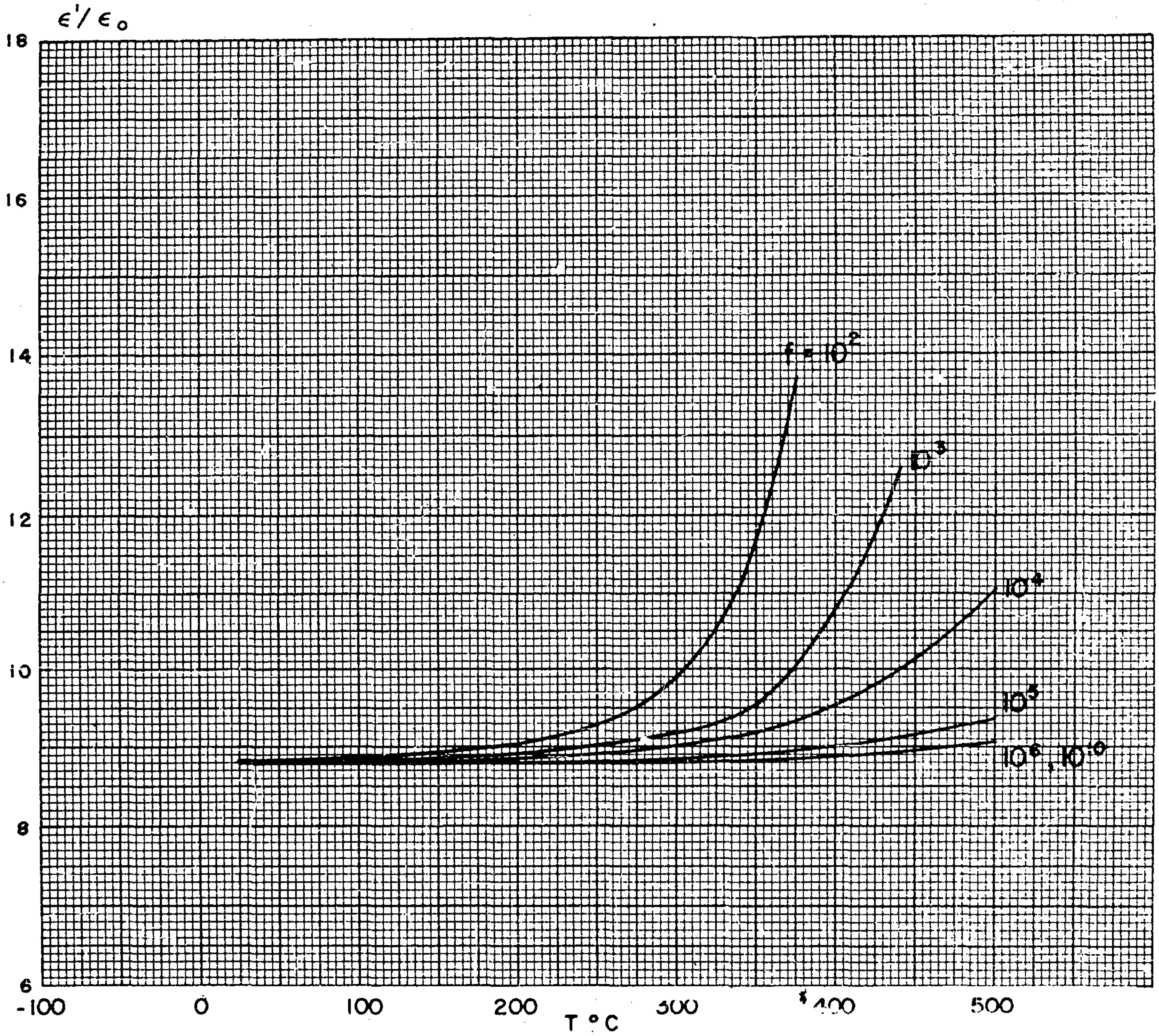
Zirconium porcelain Zi-4 Coors



Porcelains (cont.)

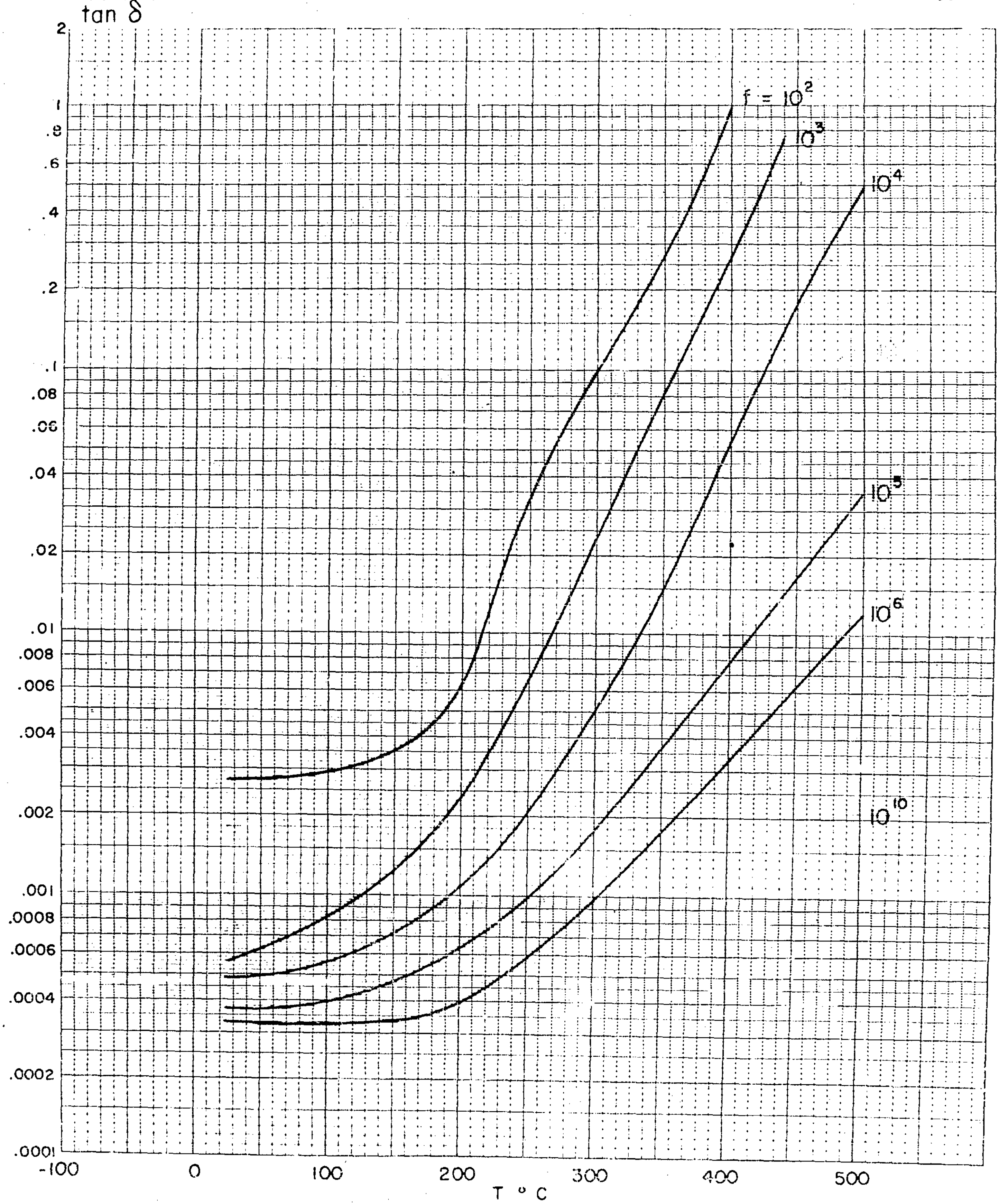
Coors AI-200

Coors



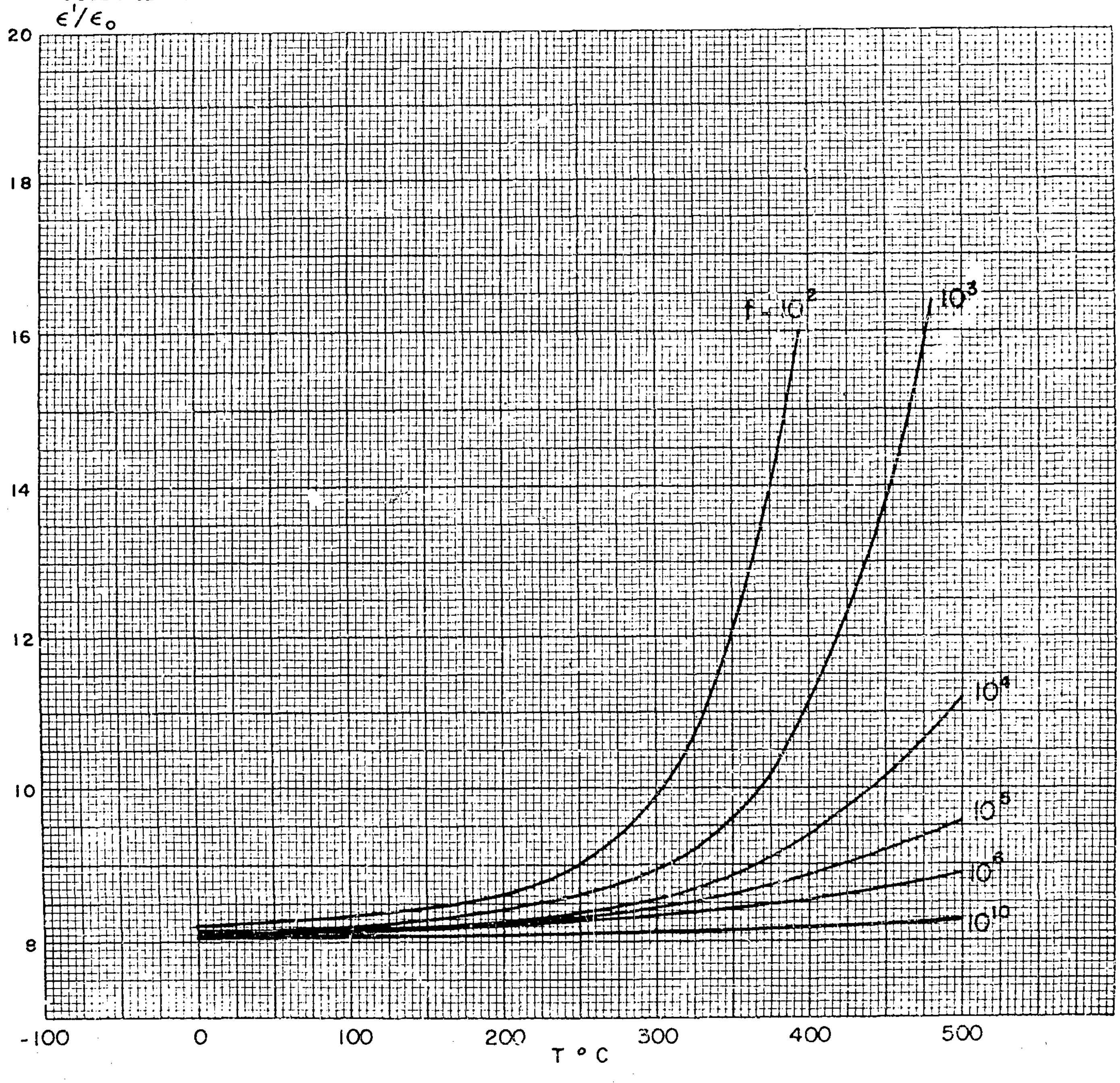
Porcelains (cont.)

Coors AI-200 Coors



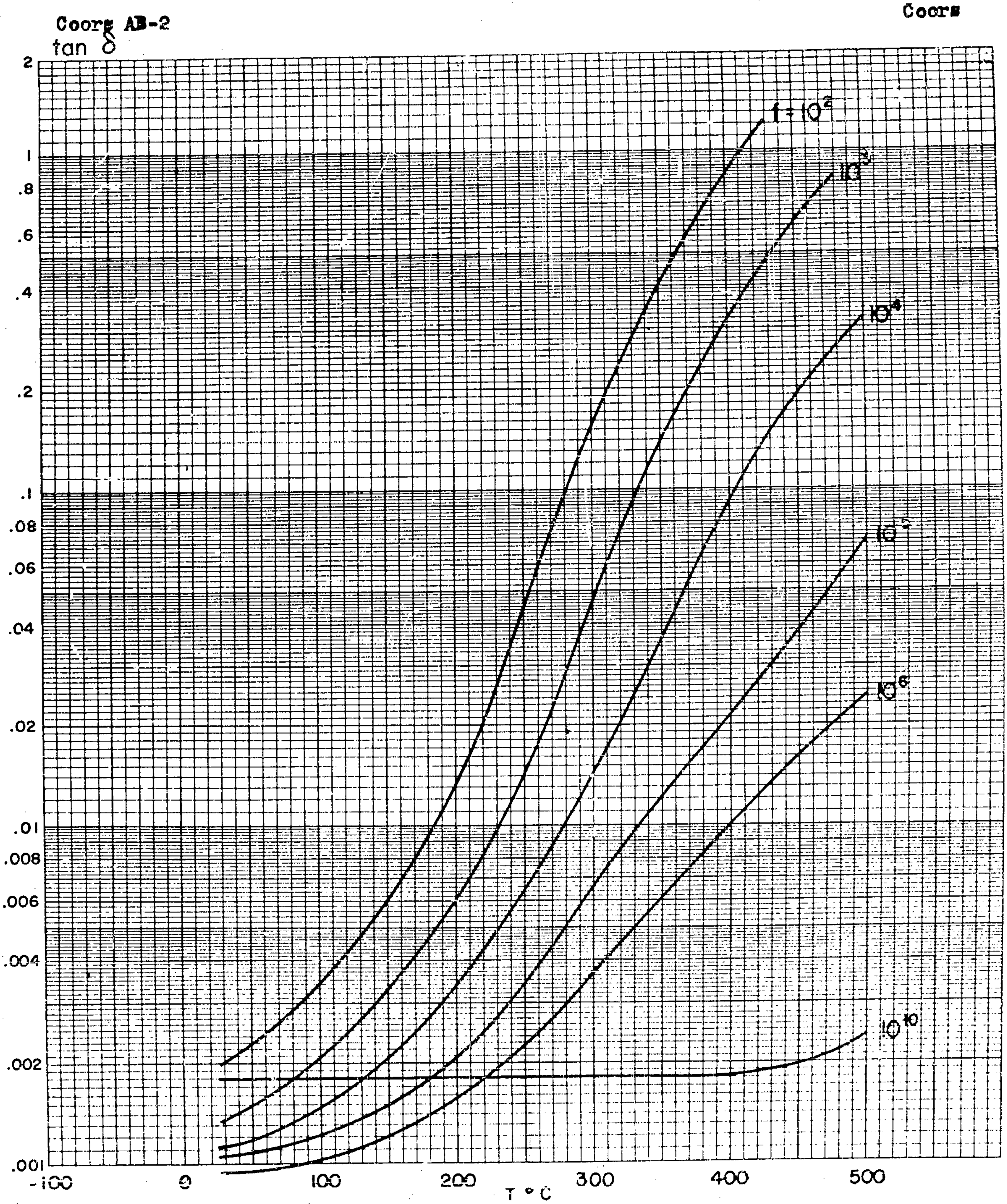
Porcelains (cont.)

Coors AB-2 Coors



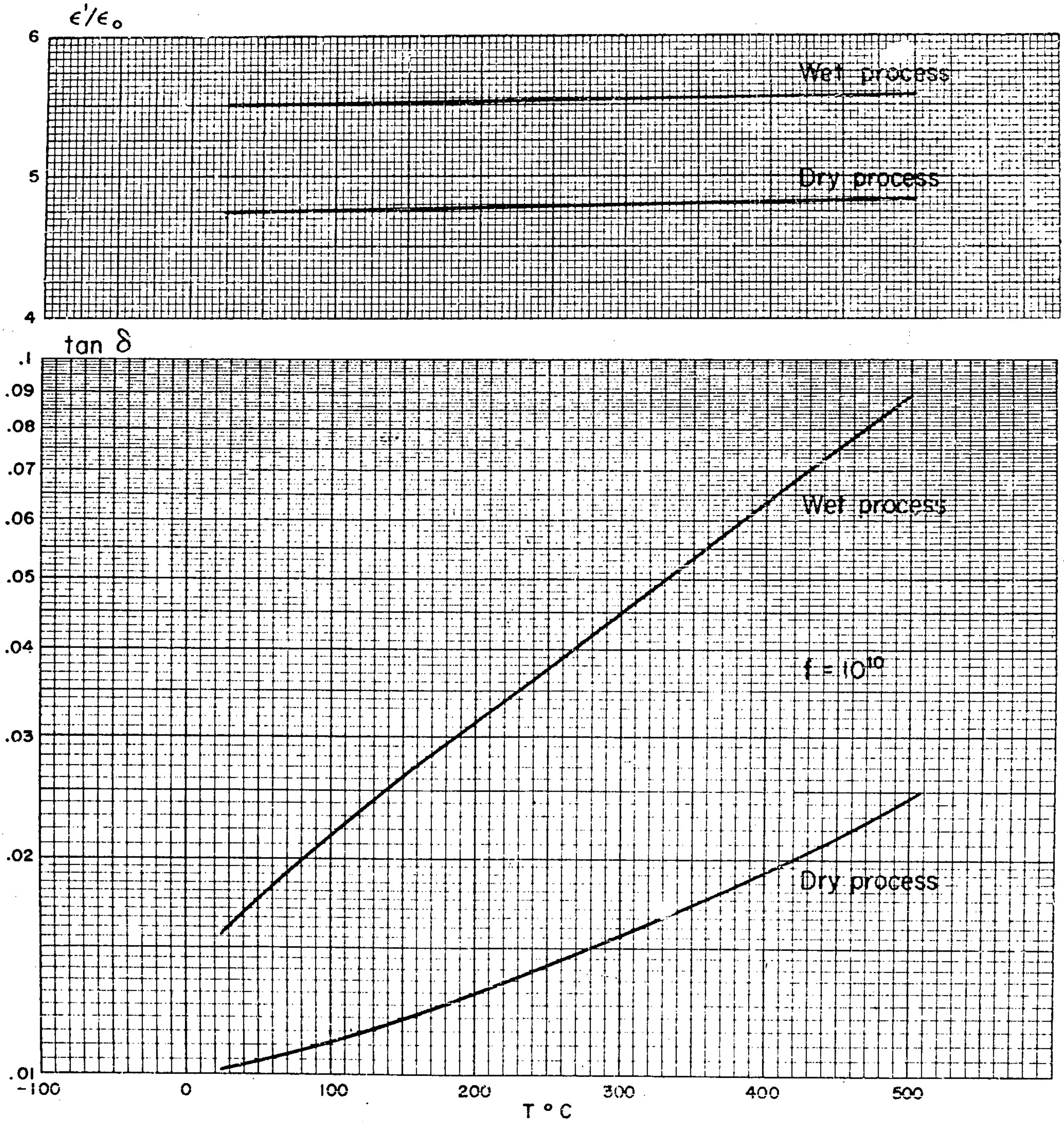
Porcelains (cont.)

Coors

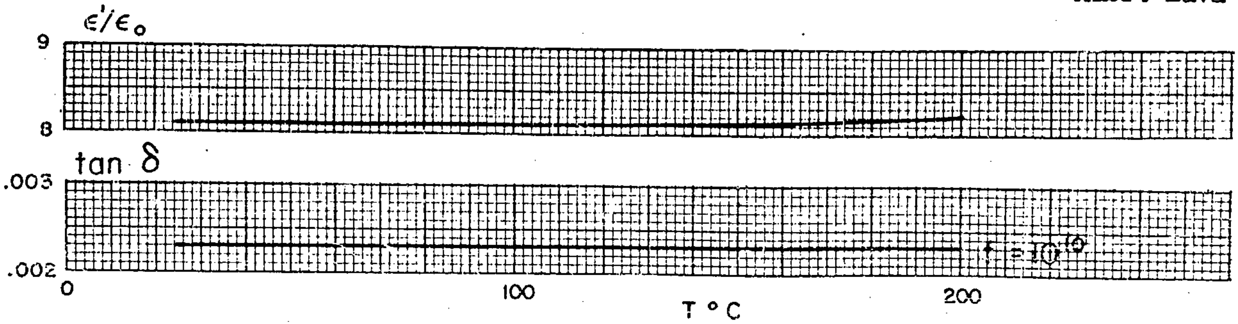


Porcelains (cont.)

Porcelain, wet process; dry process — Knox



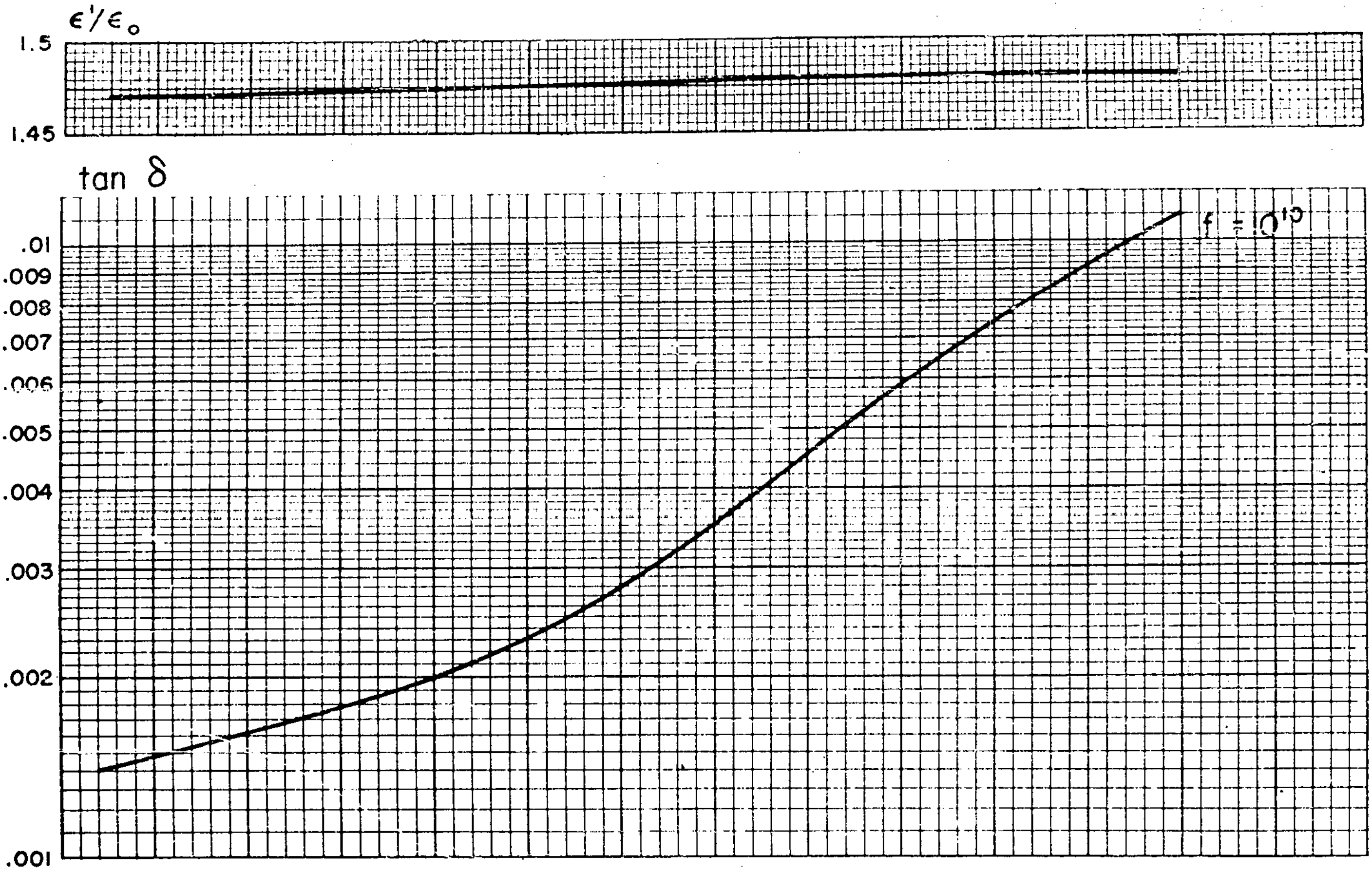
AlSiMag 491 — Amer. Lava



Miscellaneous Ceramics

Porous Ceramic AF-497

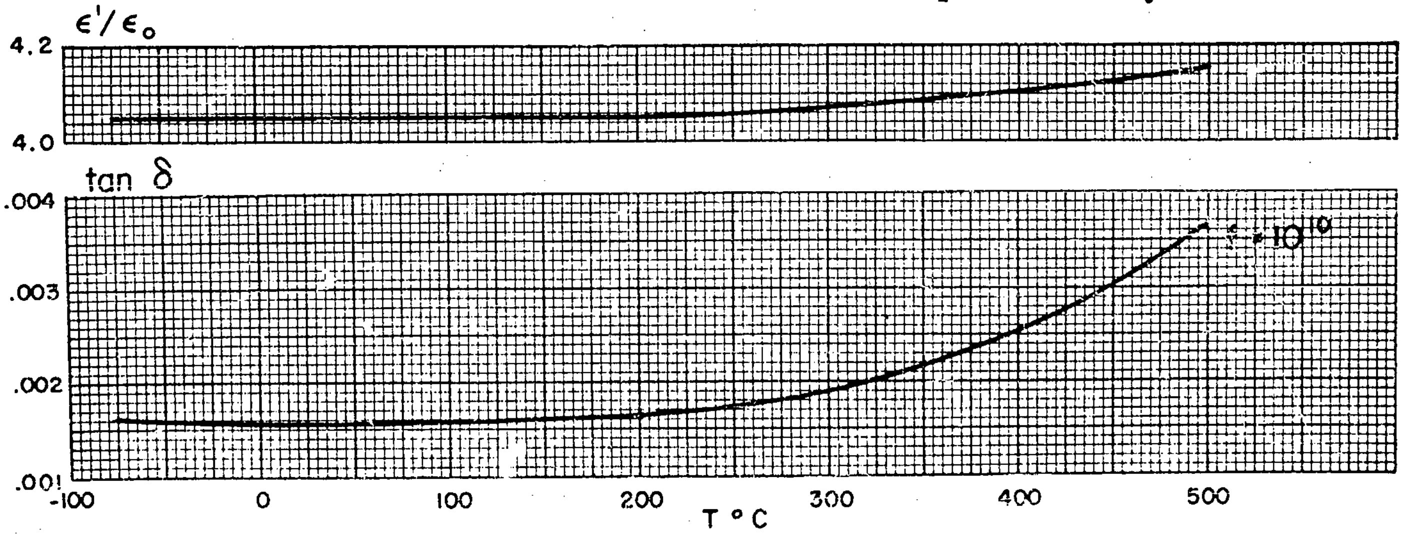
Stupakoff



Glasses

Borosilicate Glass

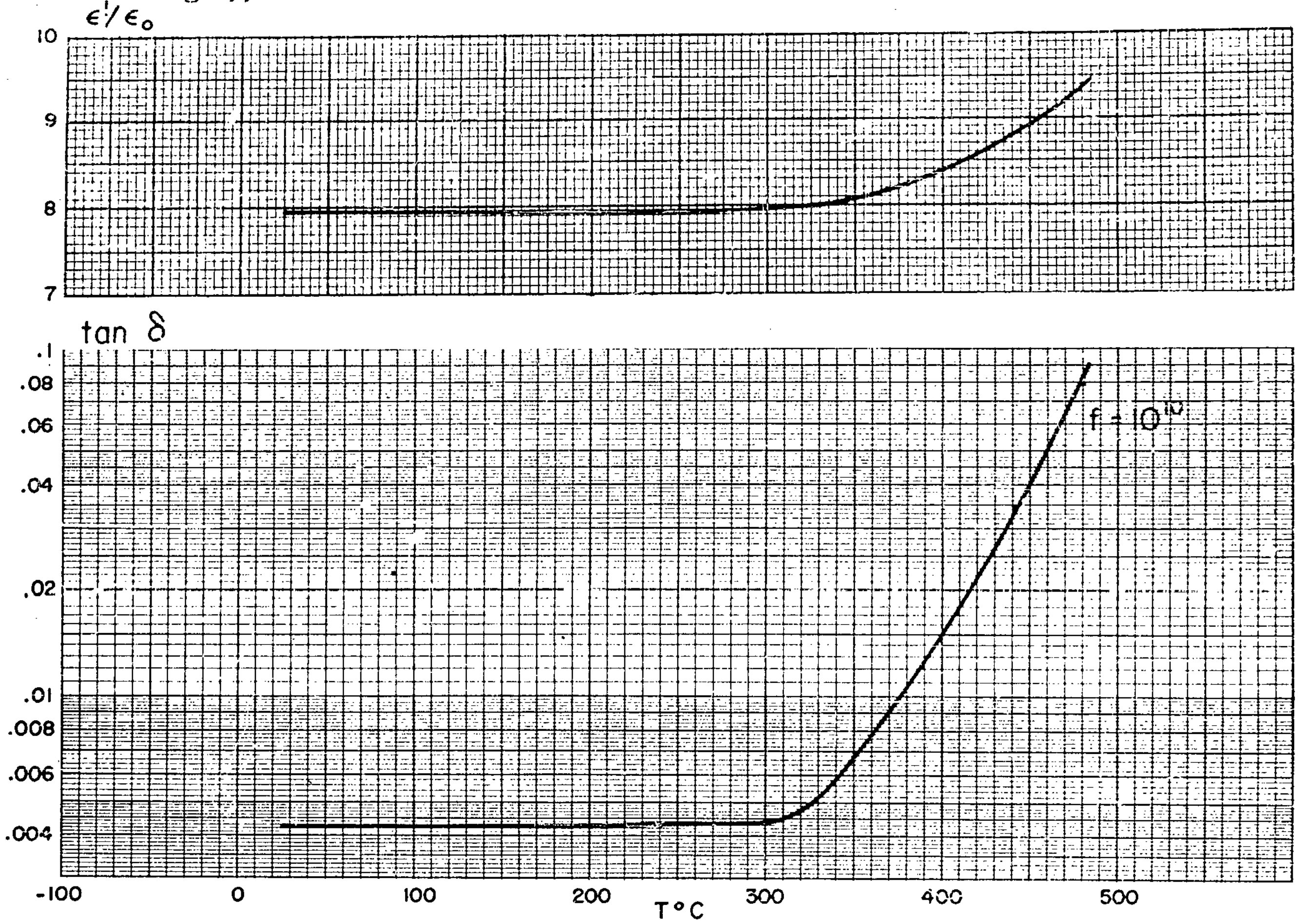
Components and Systems Lab.



Glasses (cont.)

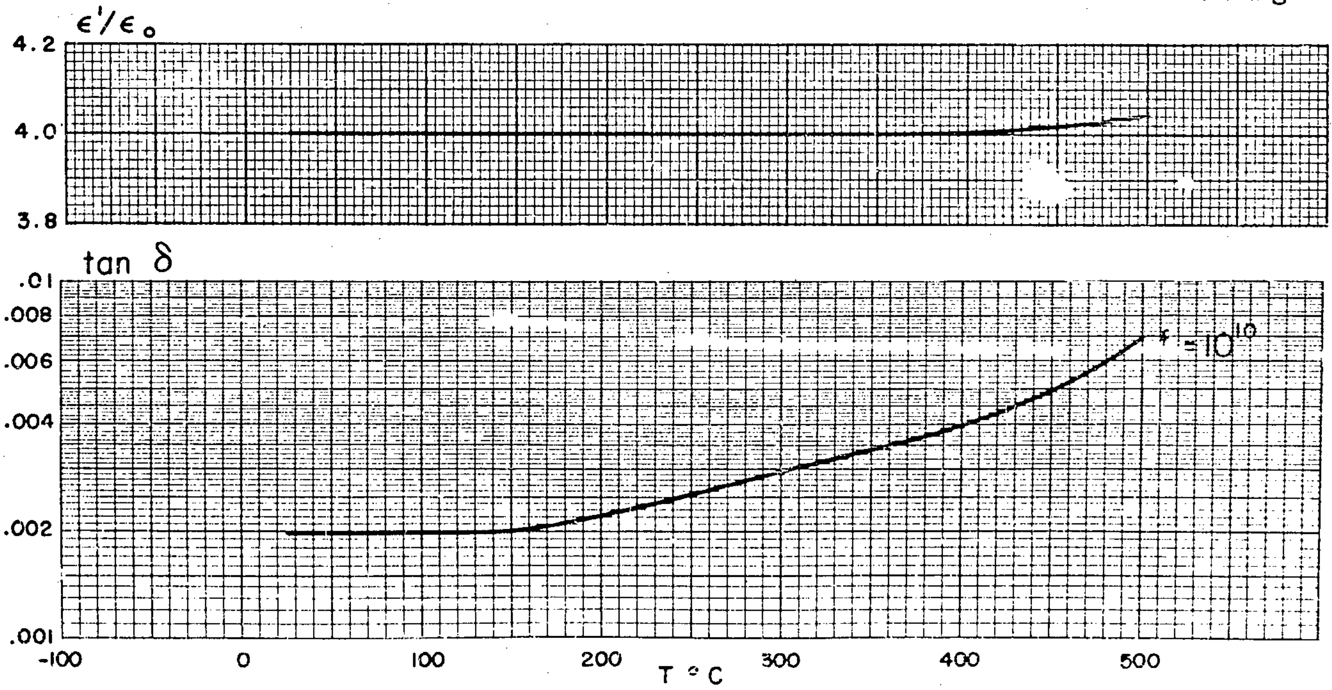
Corning 1990

Corning



Corning 7070

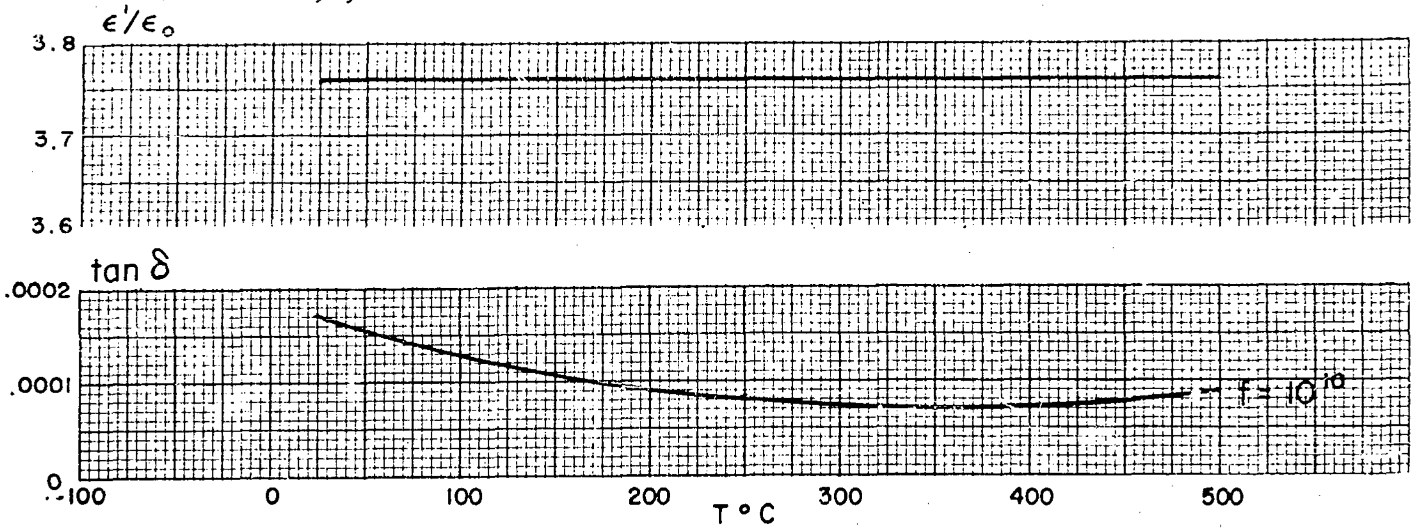
Corning



<u>Glasses (cont.)</u>

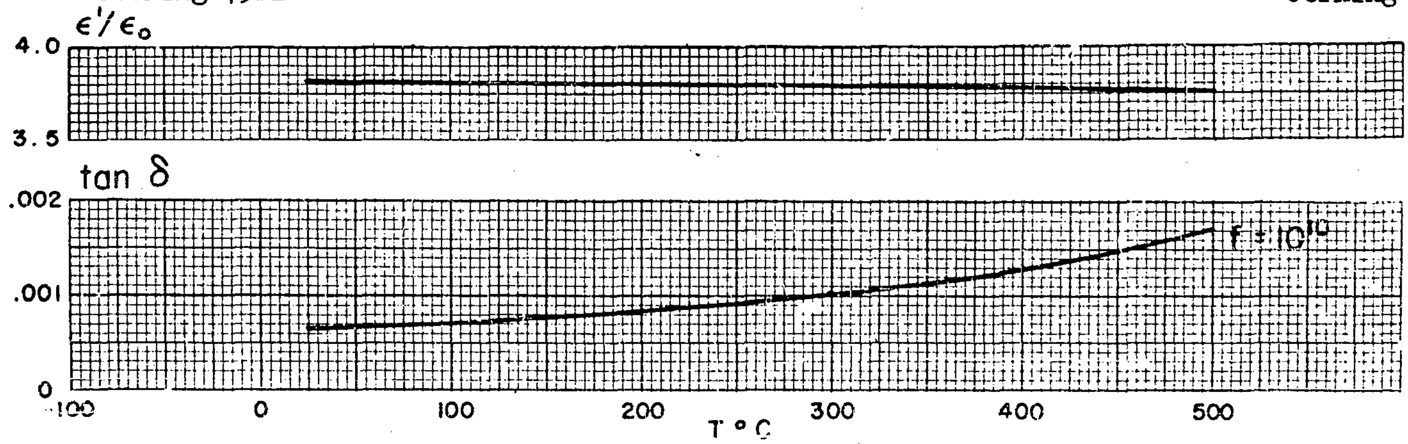
Fused Silica 915C

Corning

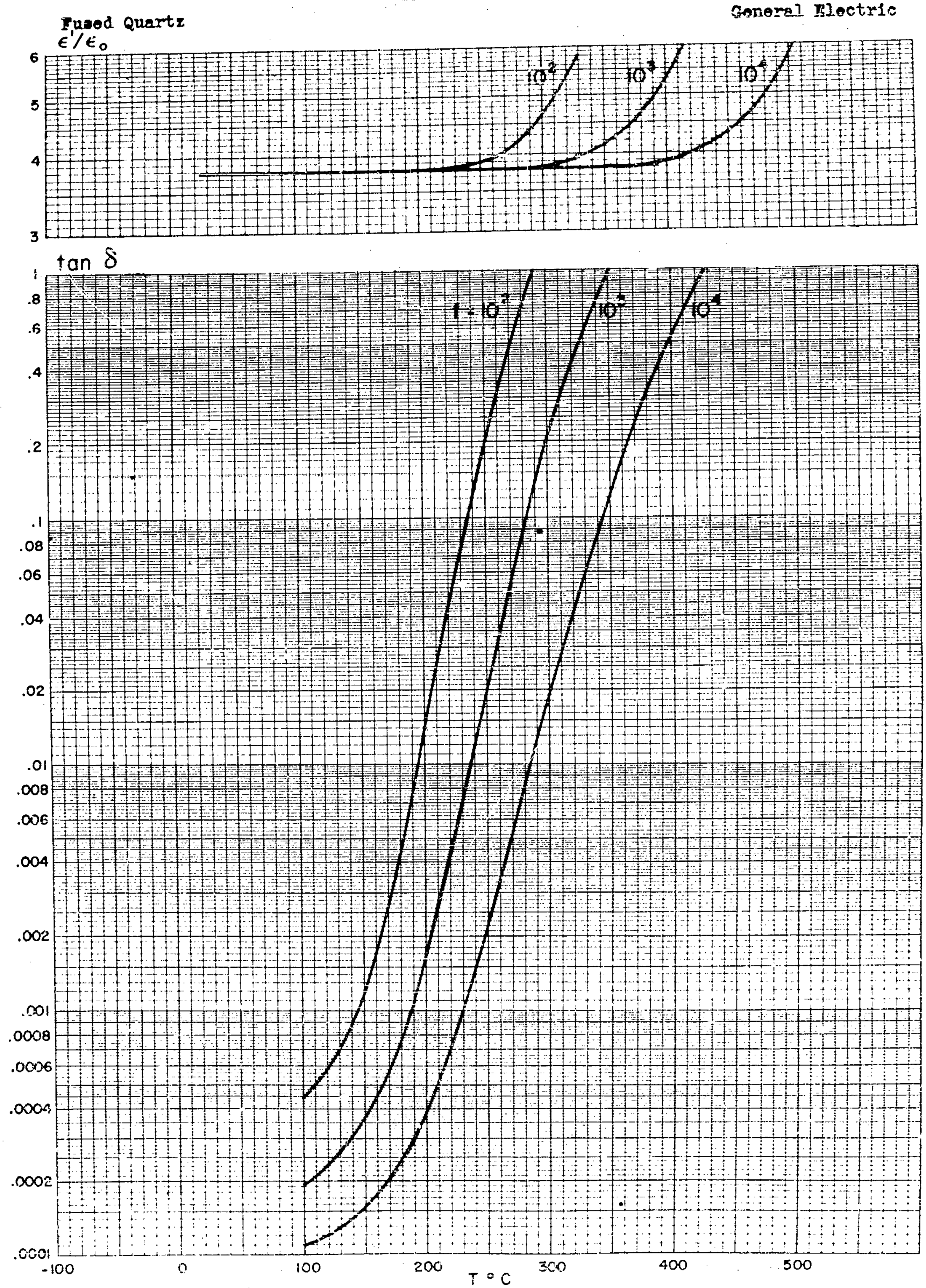


Corning 7911

Corning



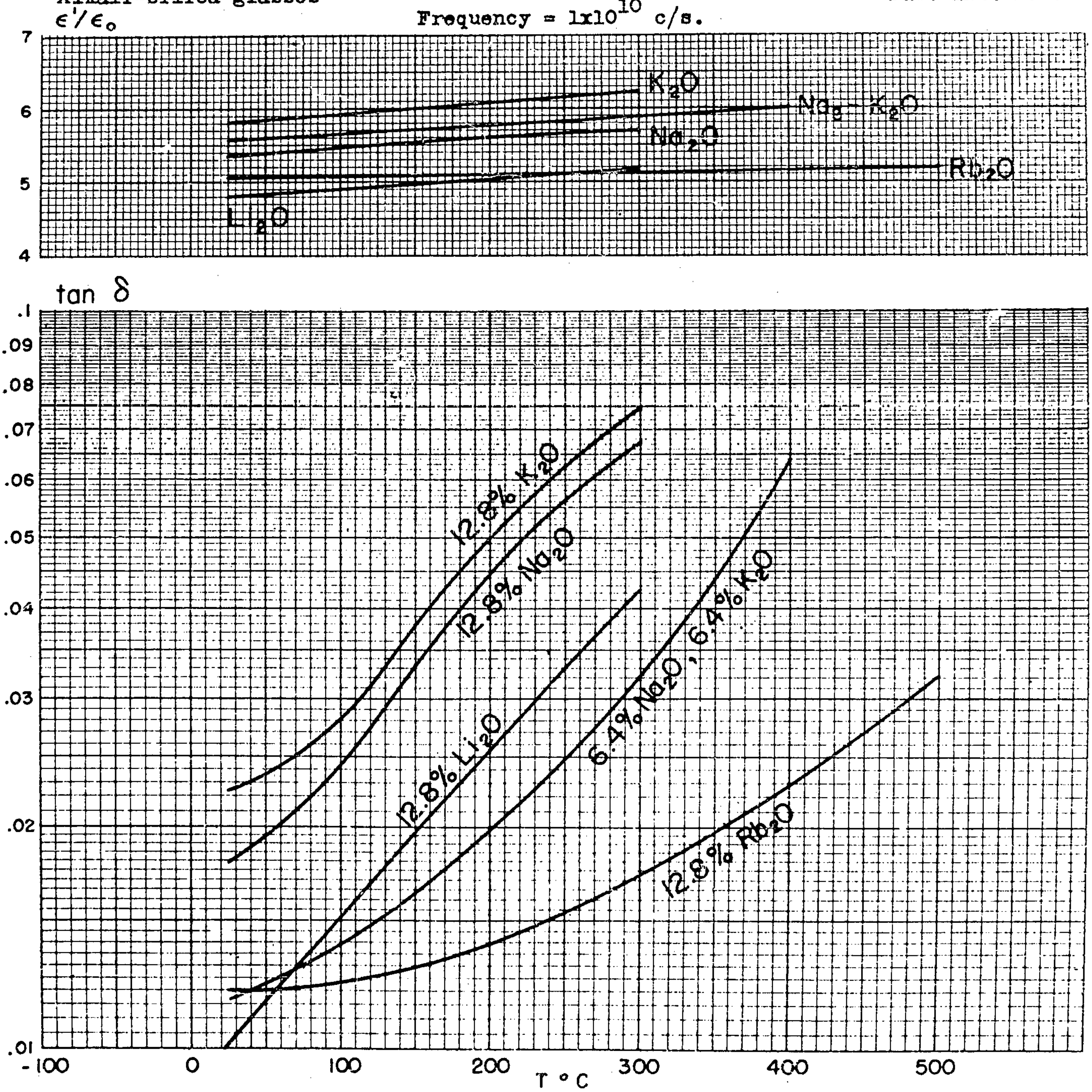
Glasses (cont.)



Glasses (cont.)

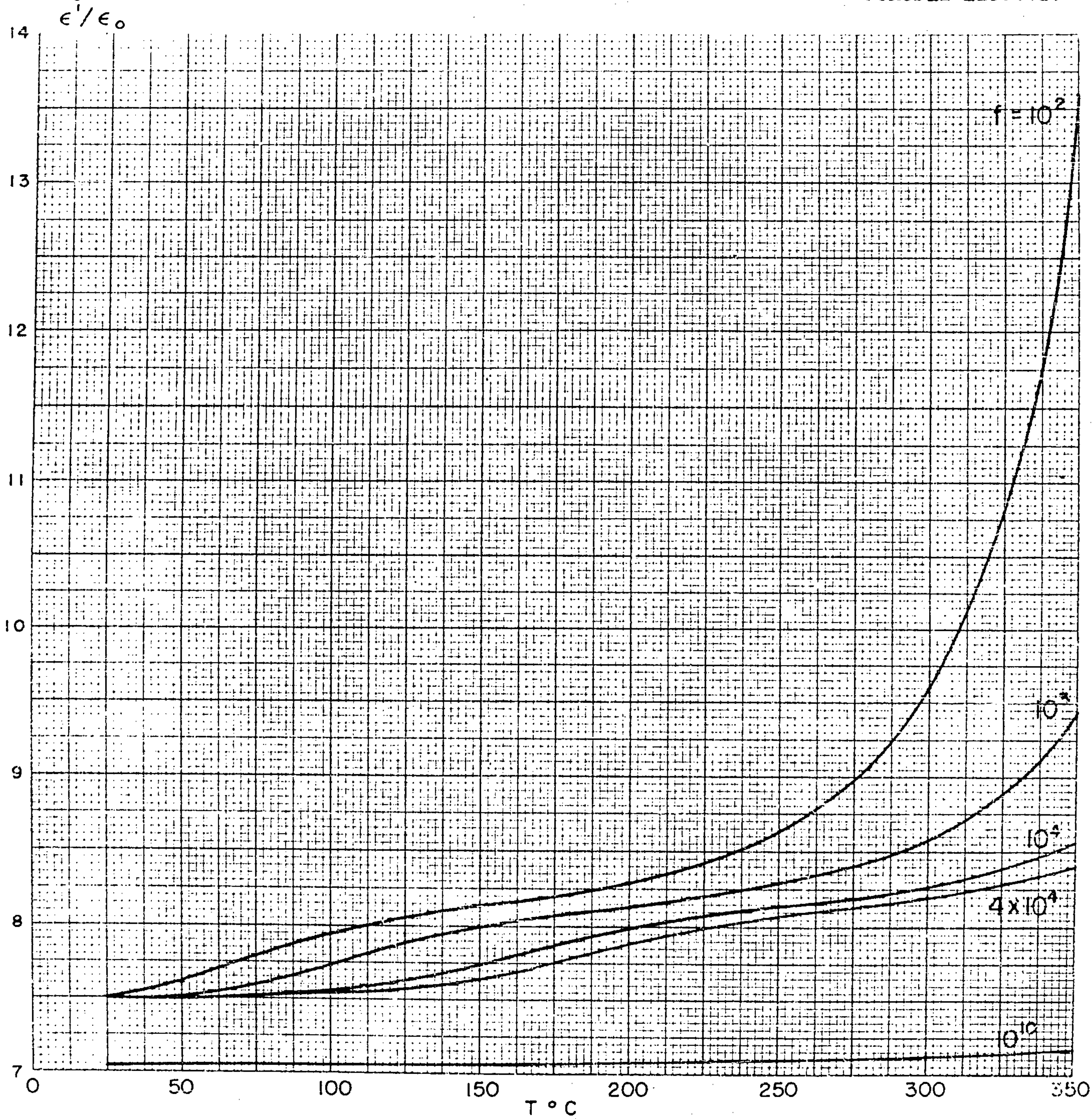
Alkali-silica-glasses

Lab. Ins. Res.



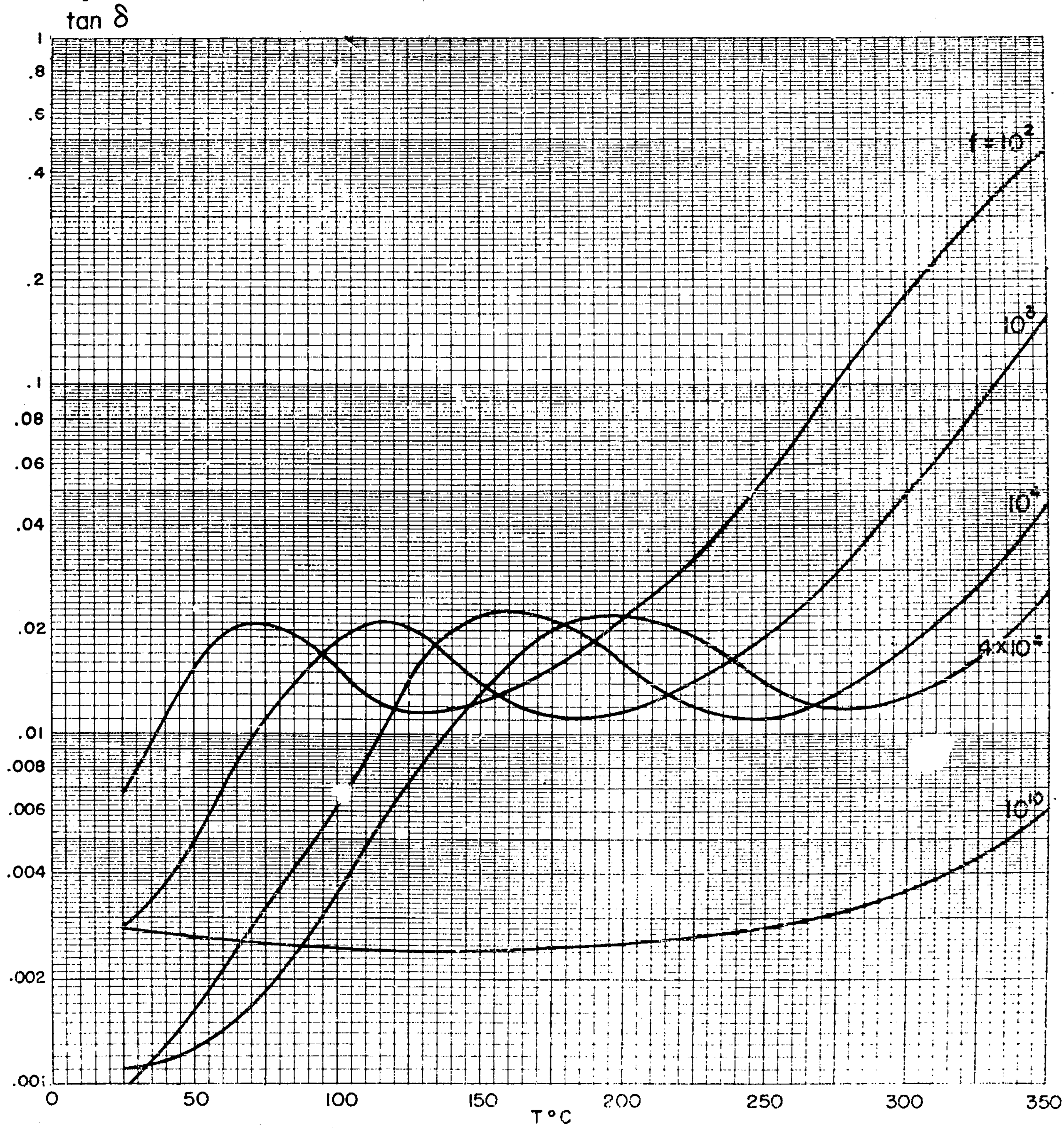
Mica and Glass

Mycalex 2821 General Electric



Mica and Glass (cont.)

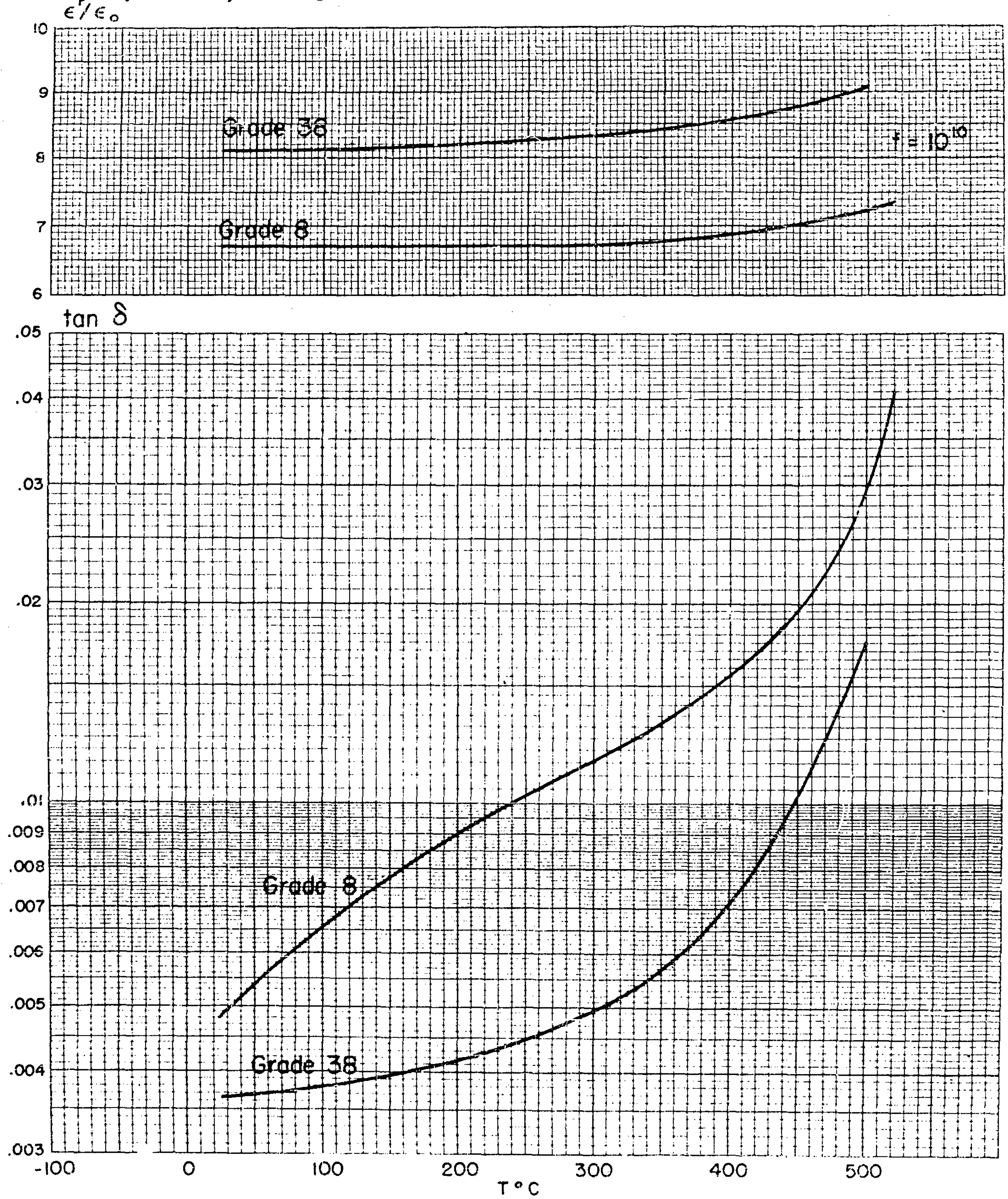
Mycalex 2821 General Electric



Mica and Glass (cont.)

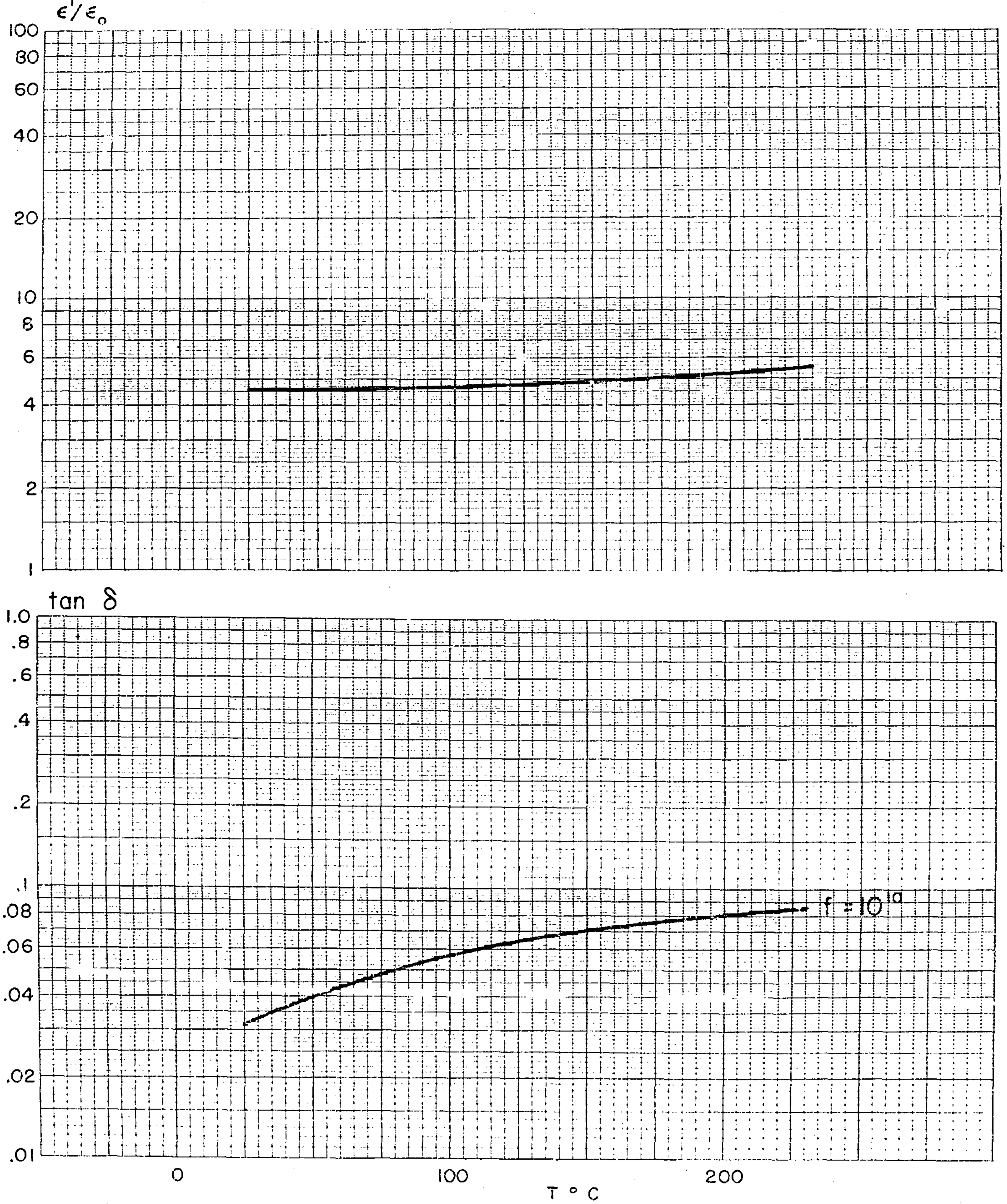
Mykroy Grade 8, Grade 38

Electronic Mech.



Phenol-formaldehyde Resins

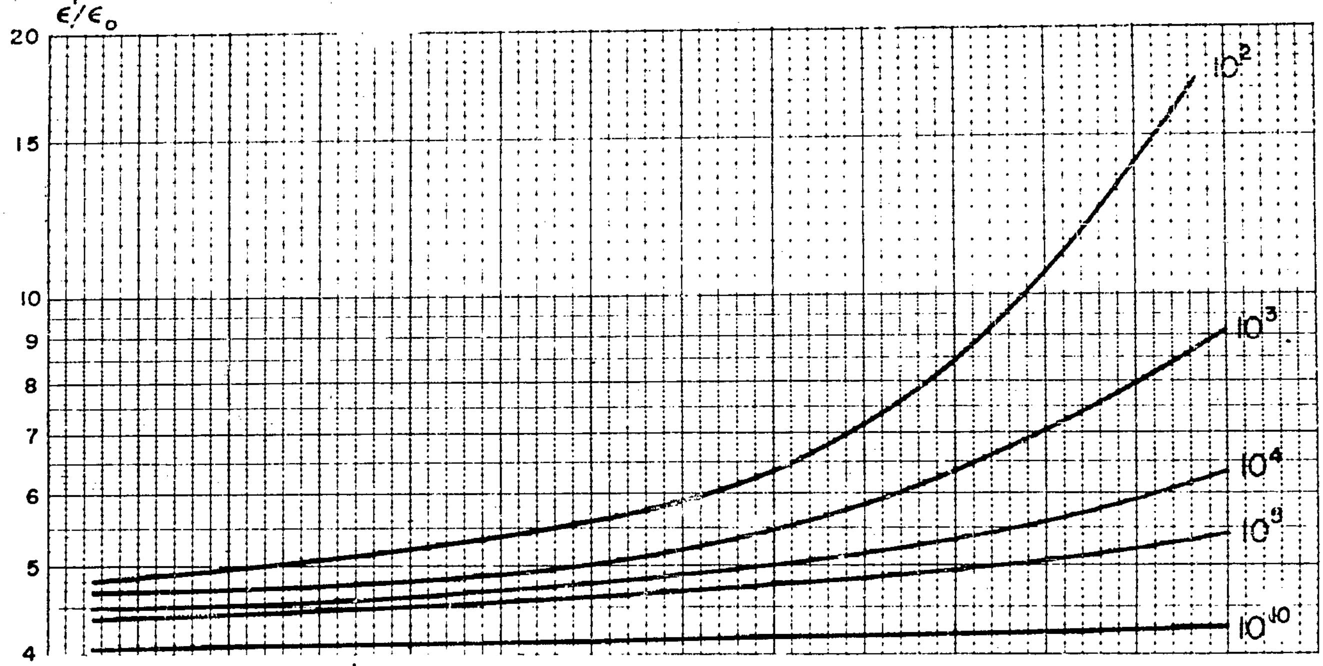
Resinox 10231 Monsanto

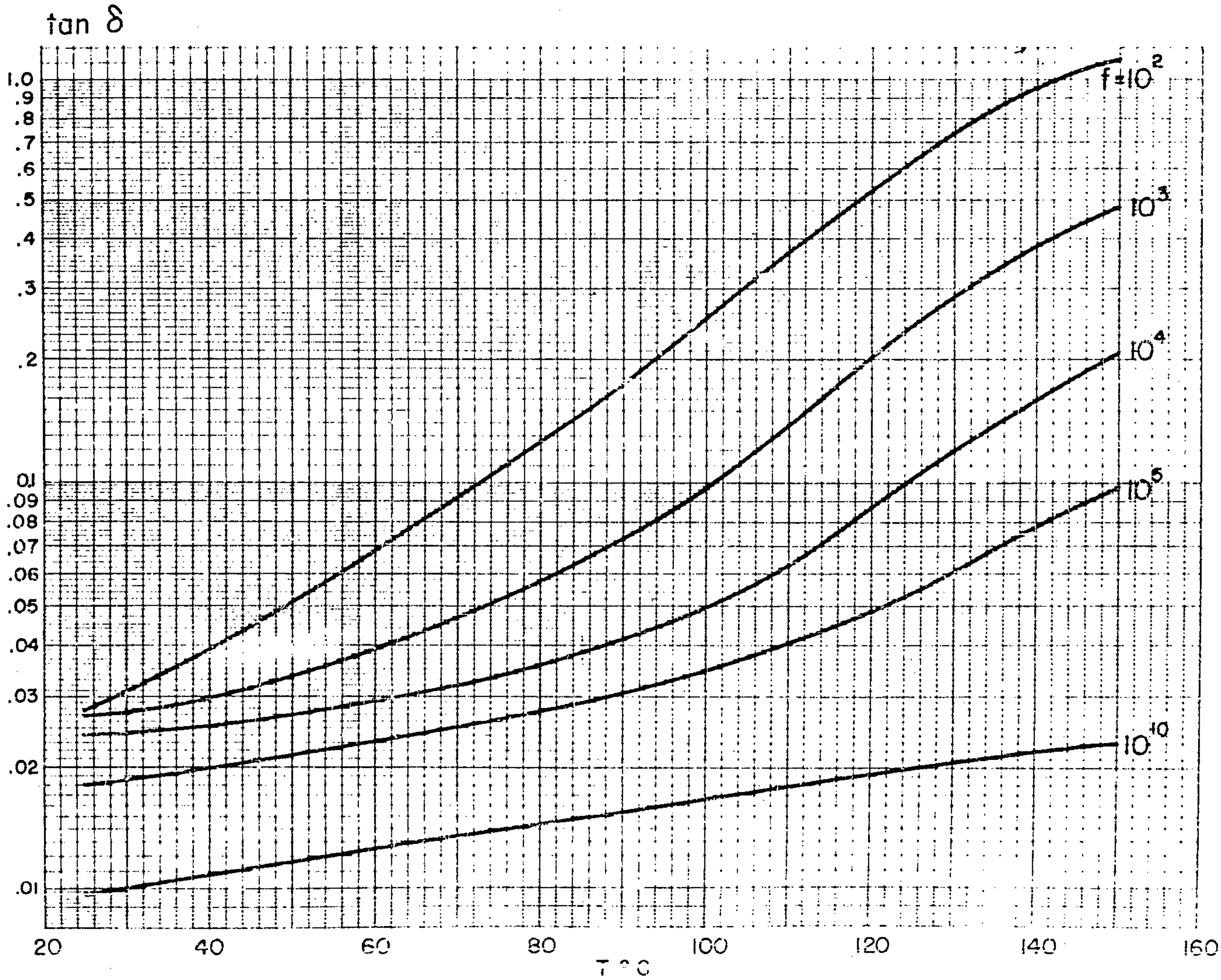


Phenol-formaldehyde Resins (cont.)

Monsanto

Resinox 10900

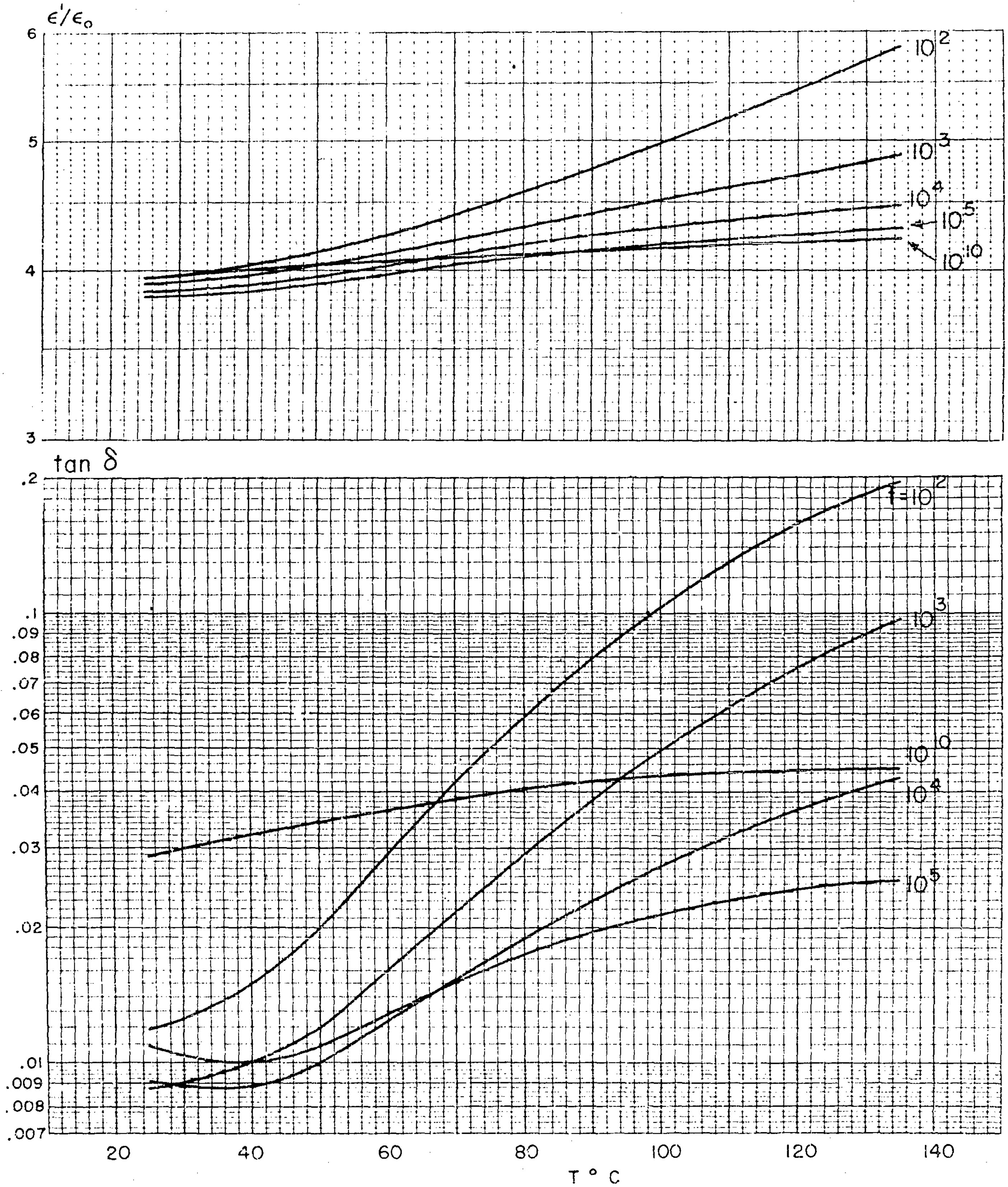




Phenol-formaldehyde Resins (cont.)

Taylor Grade GGG

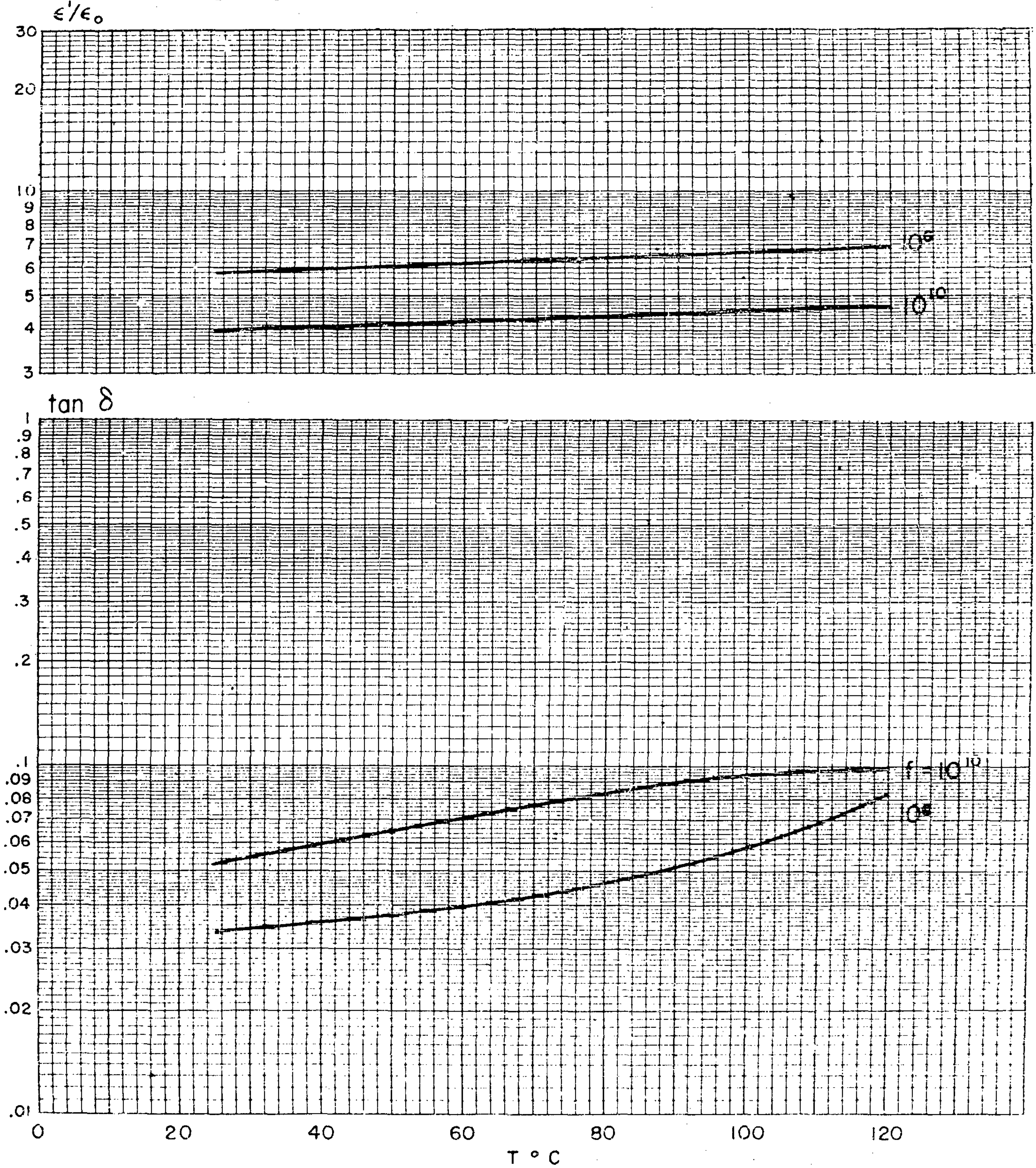
Taylor



Melamine-formaldehyde Resin

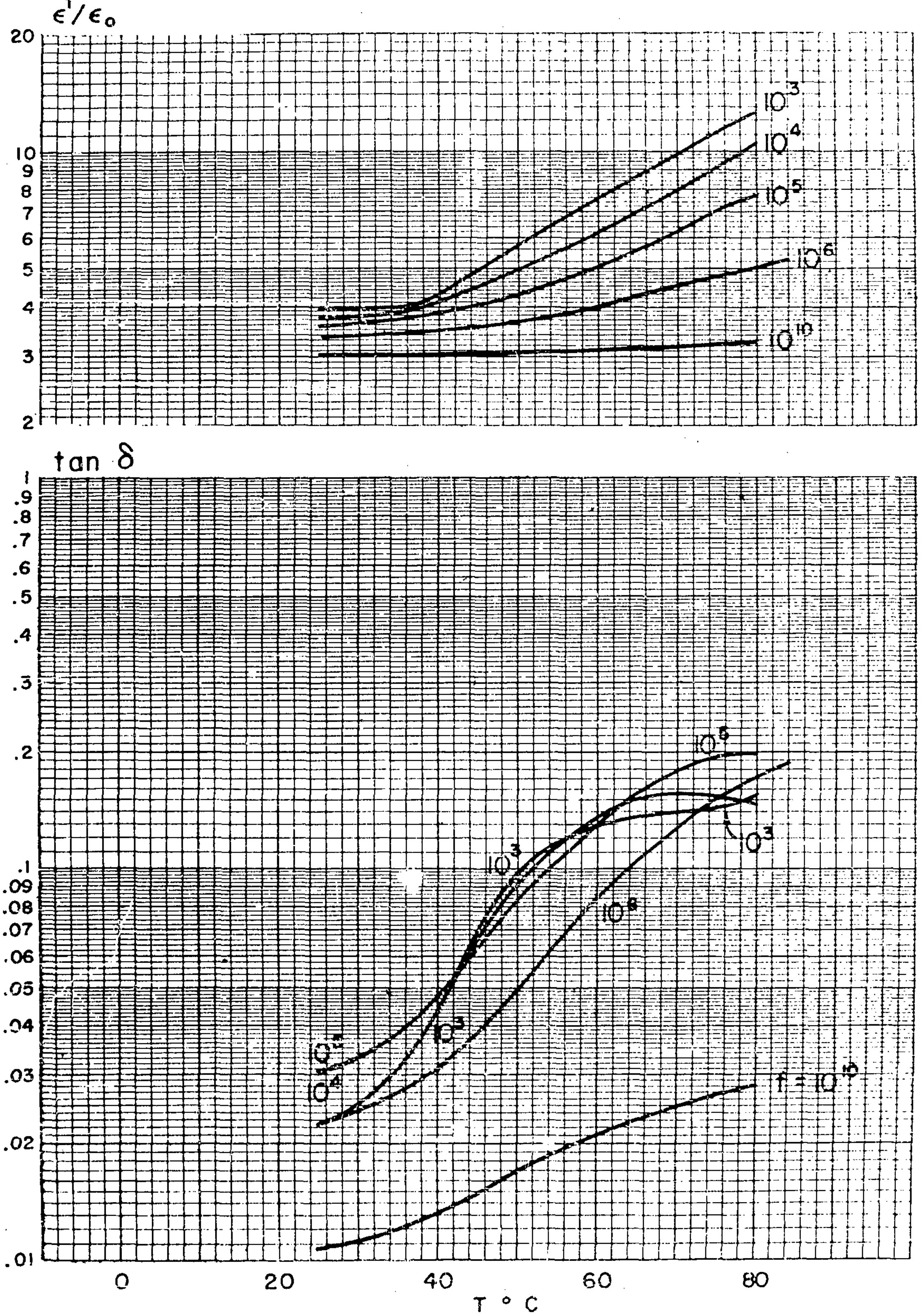
Melmac Molding Compound 1502

Amer. Cyanamid

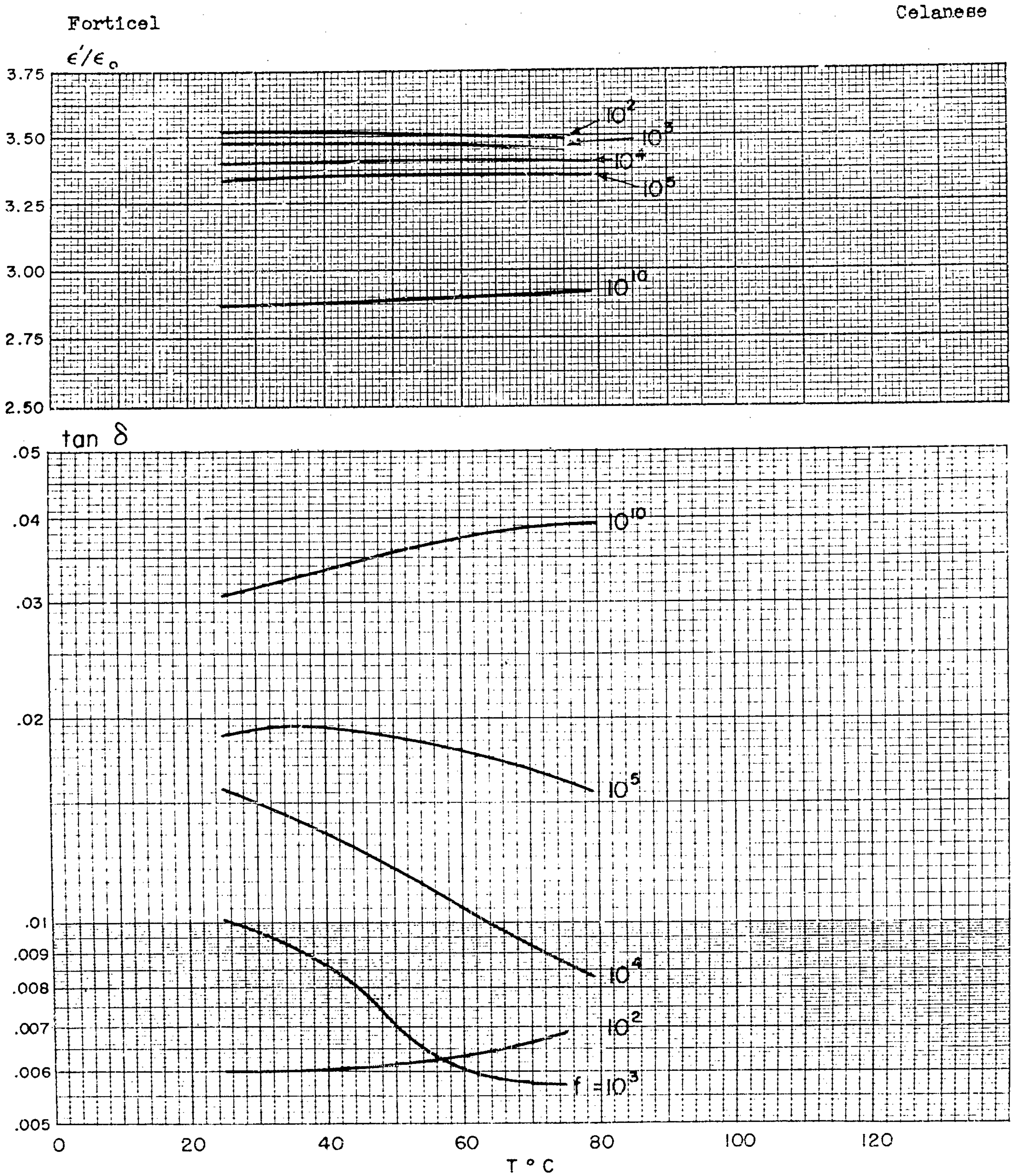


Polyamide Resin

Nylon FM 10,001 DuPont



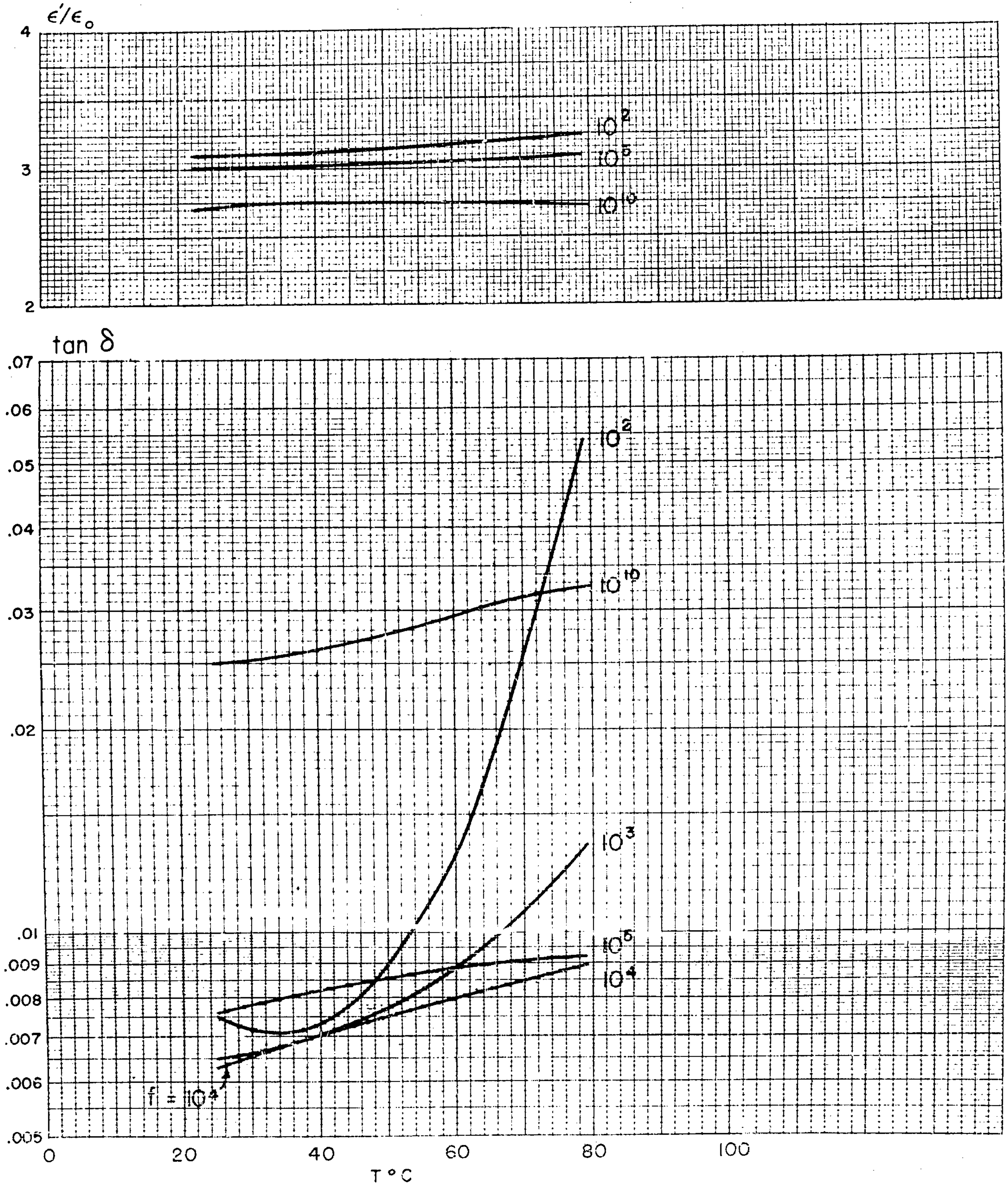
Cellulose Propionate



Ethyl Cellulose

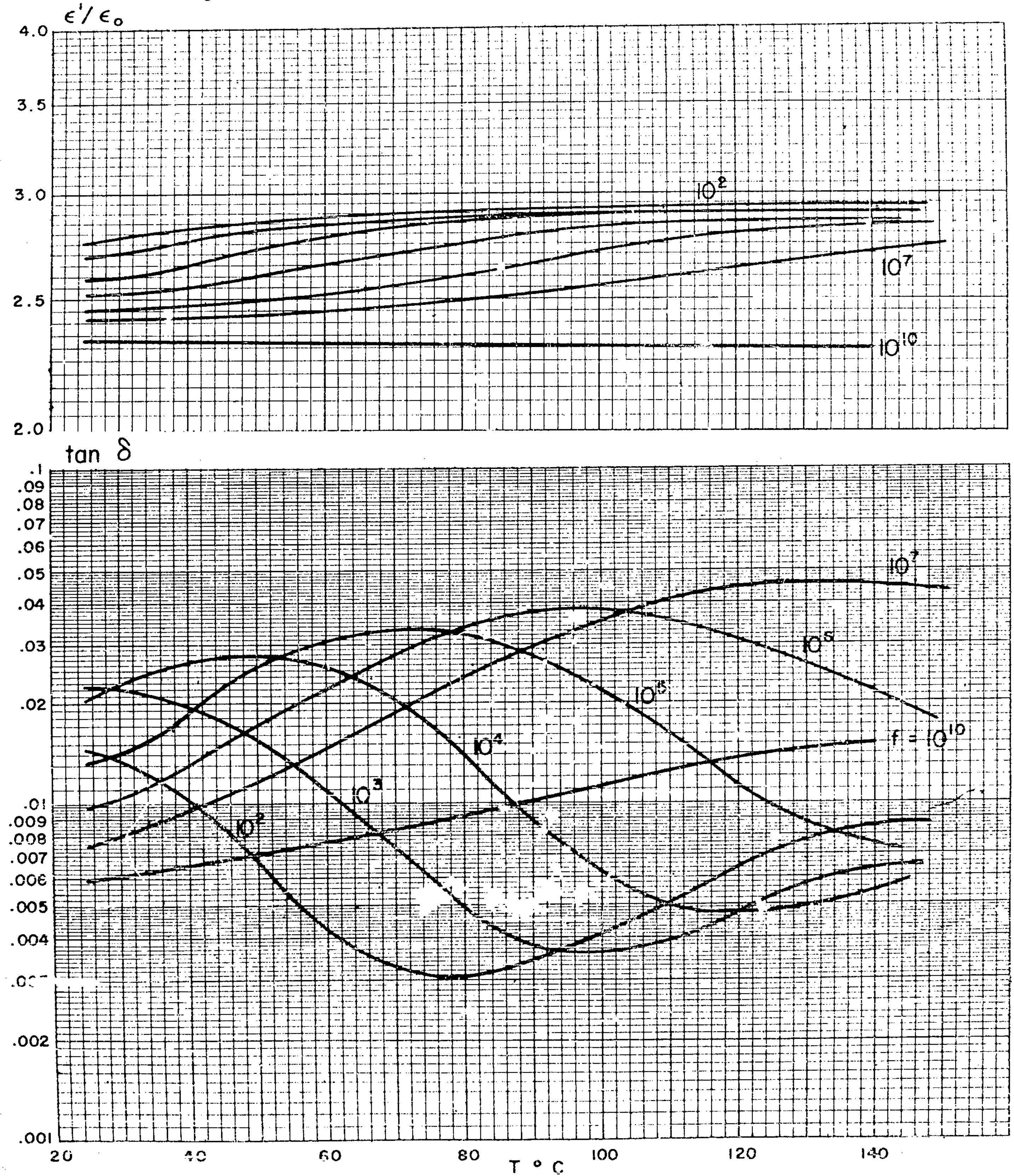
Ethocel LT5

Celanese



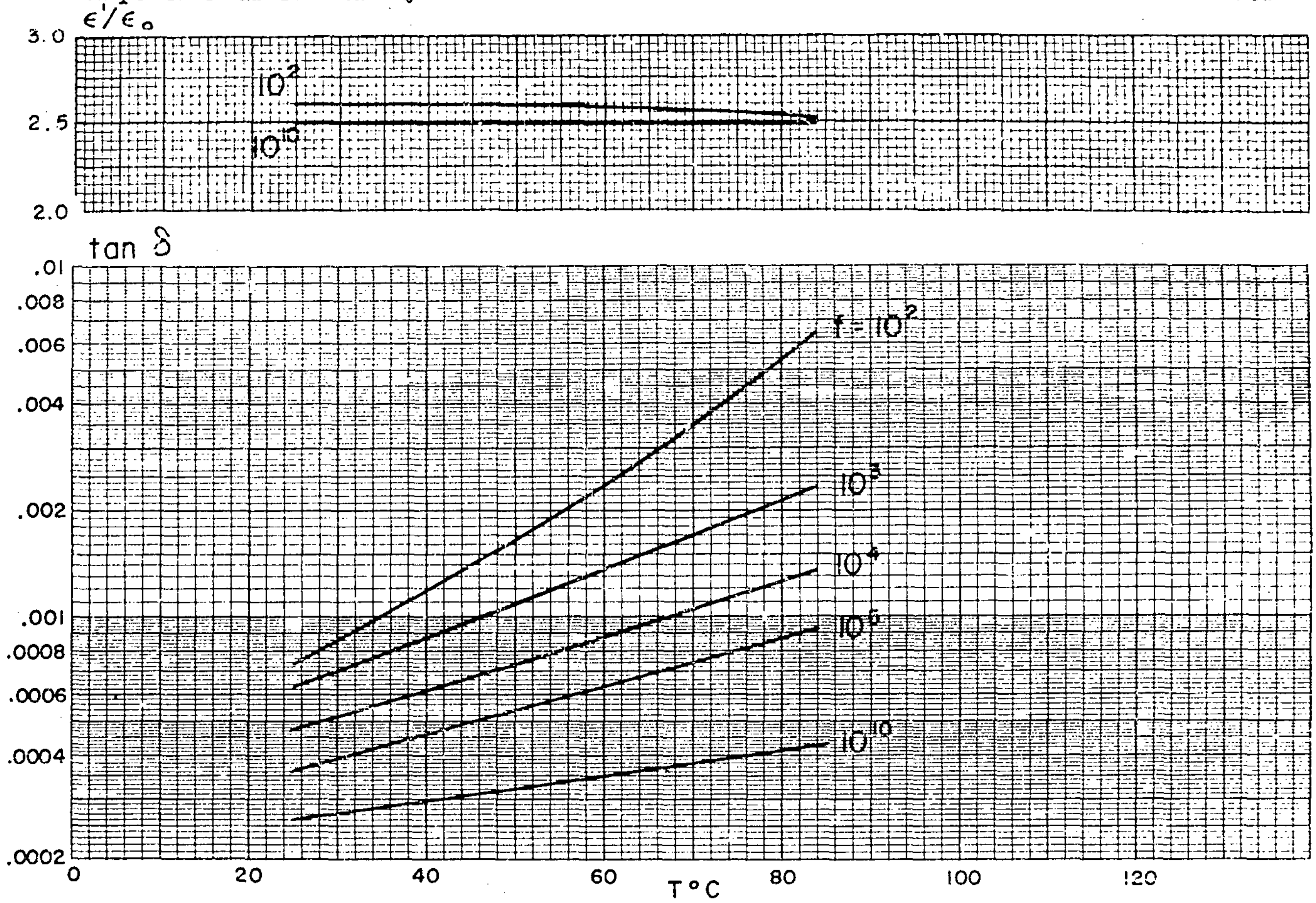
Polychlorotrifluoroethylene

Kel-F Grade 300 — Kellogg

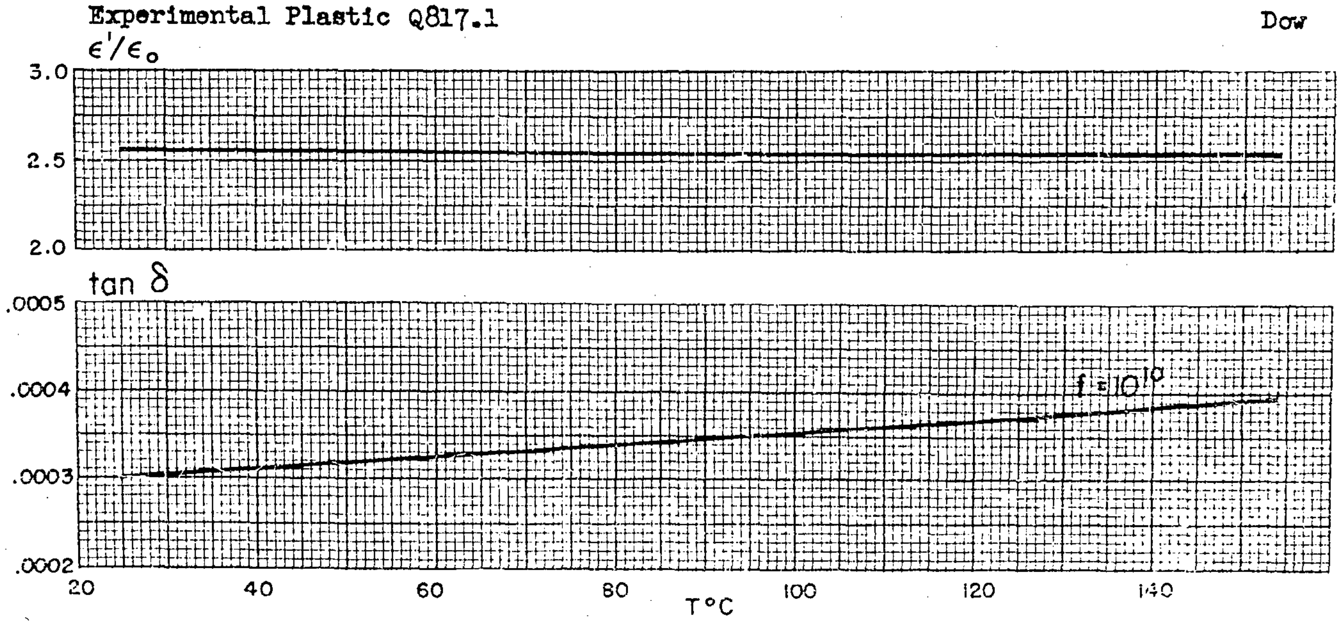


Miscellaneous Vinyls

Experimental Plastic Q406 Dow



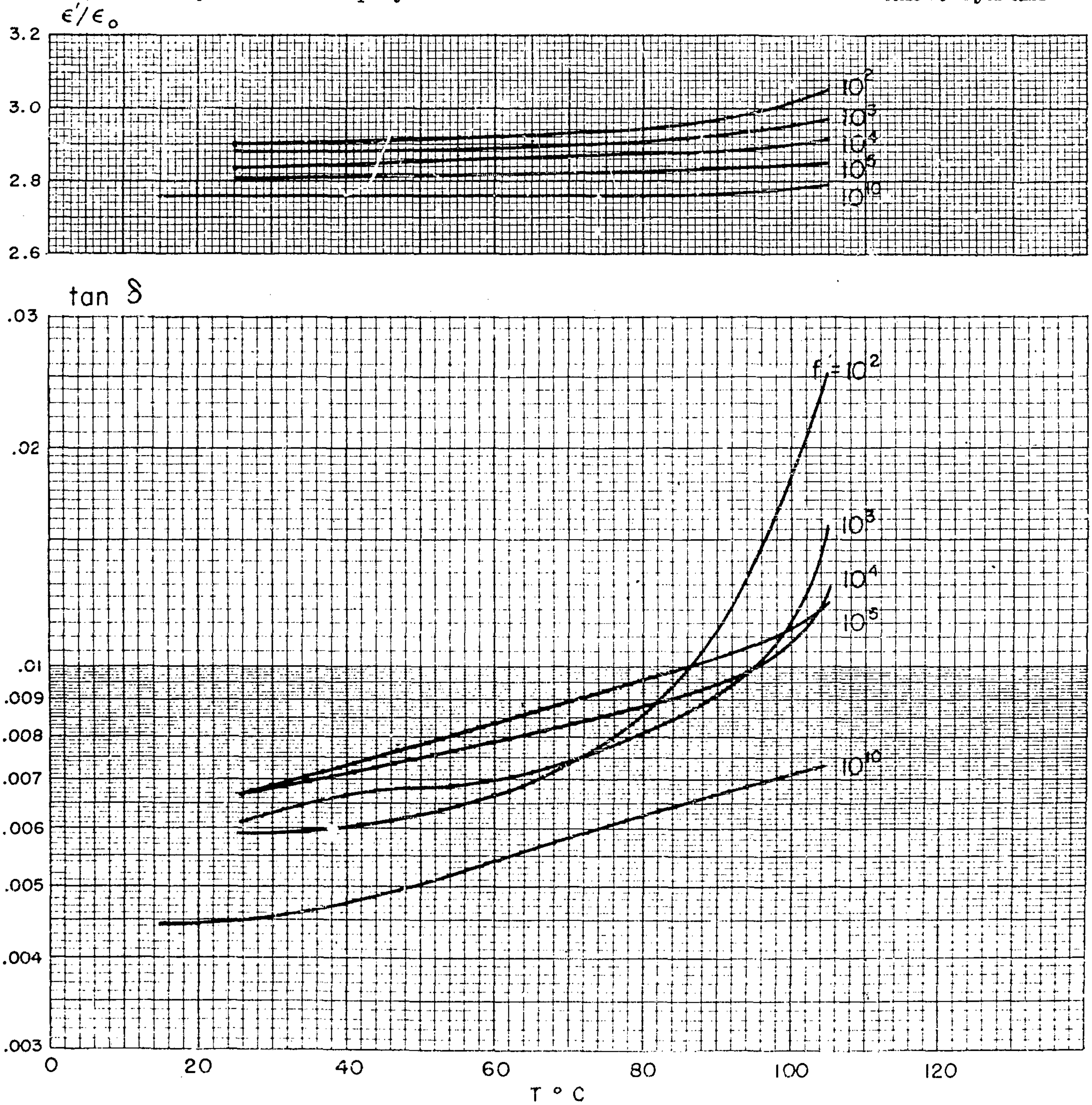
Experimental Plastic Q817.1 Dow



Styrene Copolymers, Linear

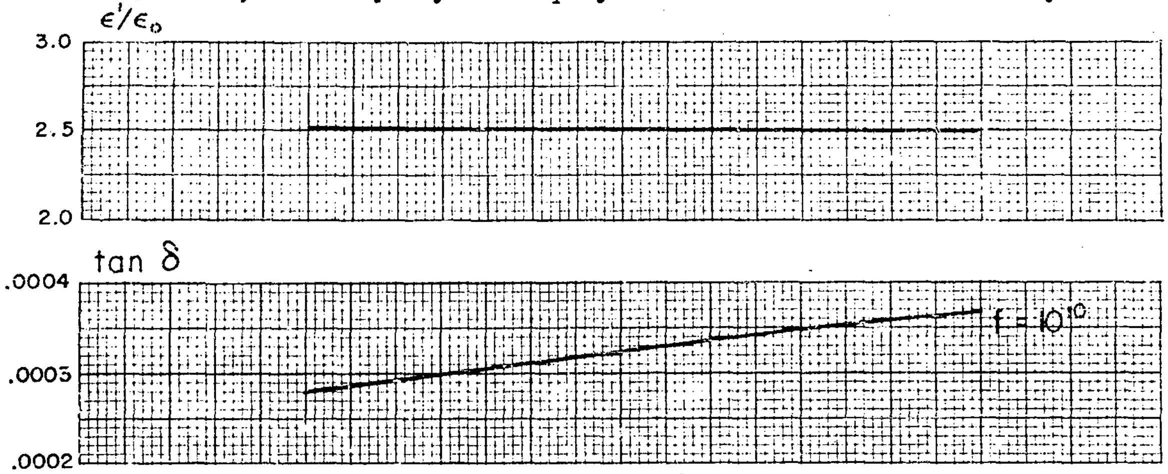
Styrene-acrylonitrile copolymer

Amer. Cyanamid



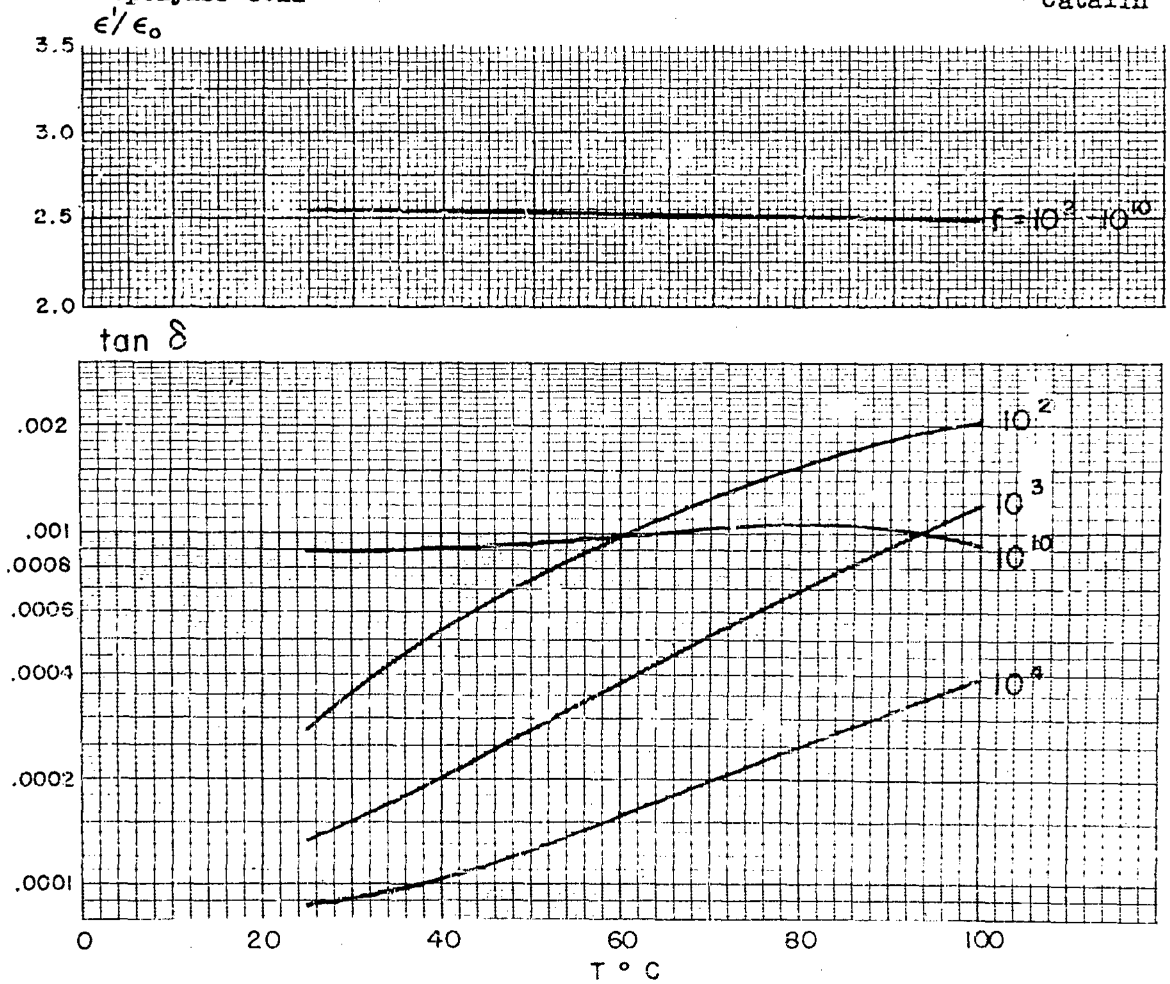
Styrene Copolymers, Linear (cont.)

Styrene-2,4-dimethylstyrene copolymer | Amer. Cyanamid



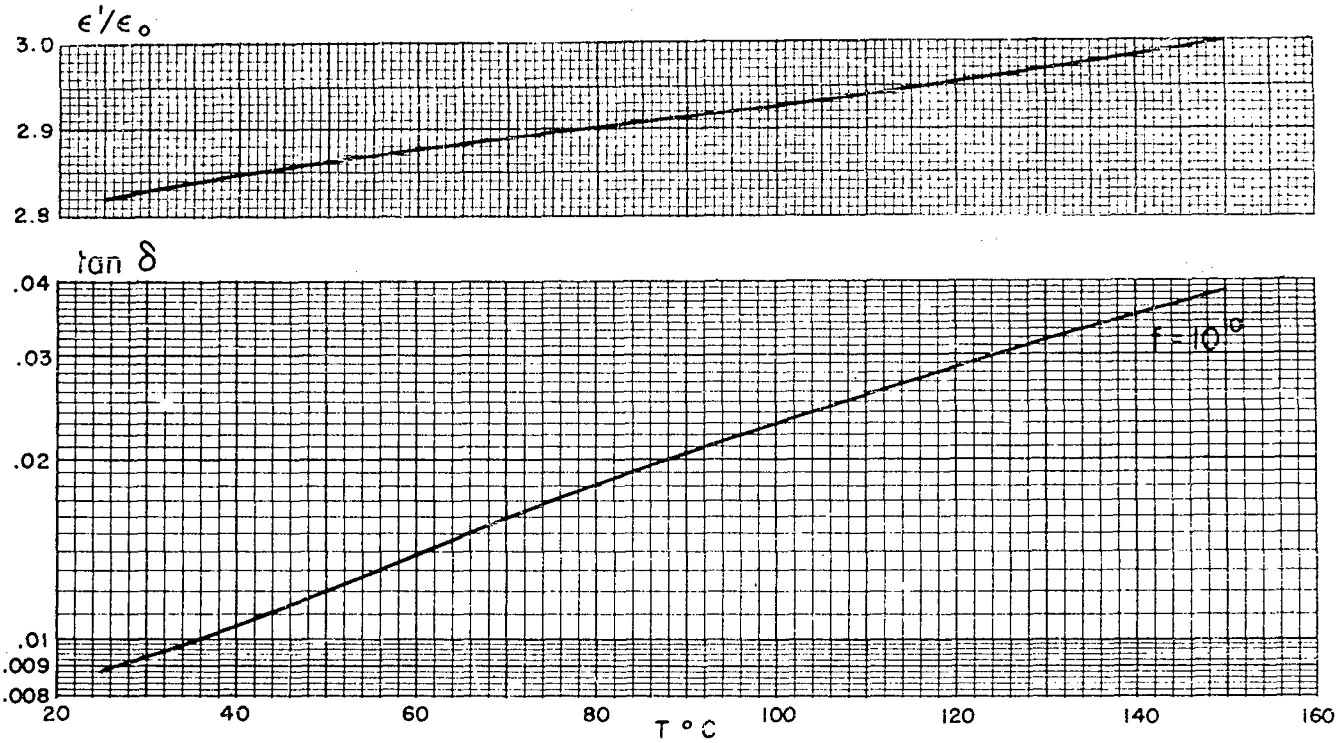
Styrene Copolymers, Cross-linked

Copolymer 8012 | Catalin

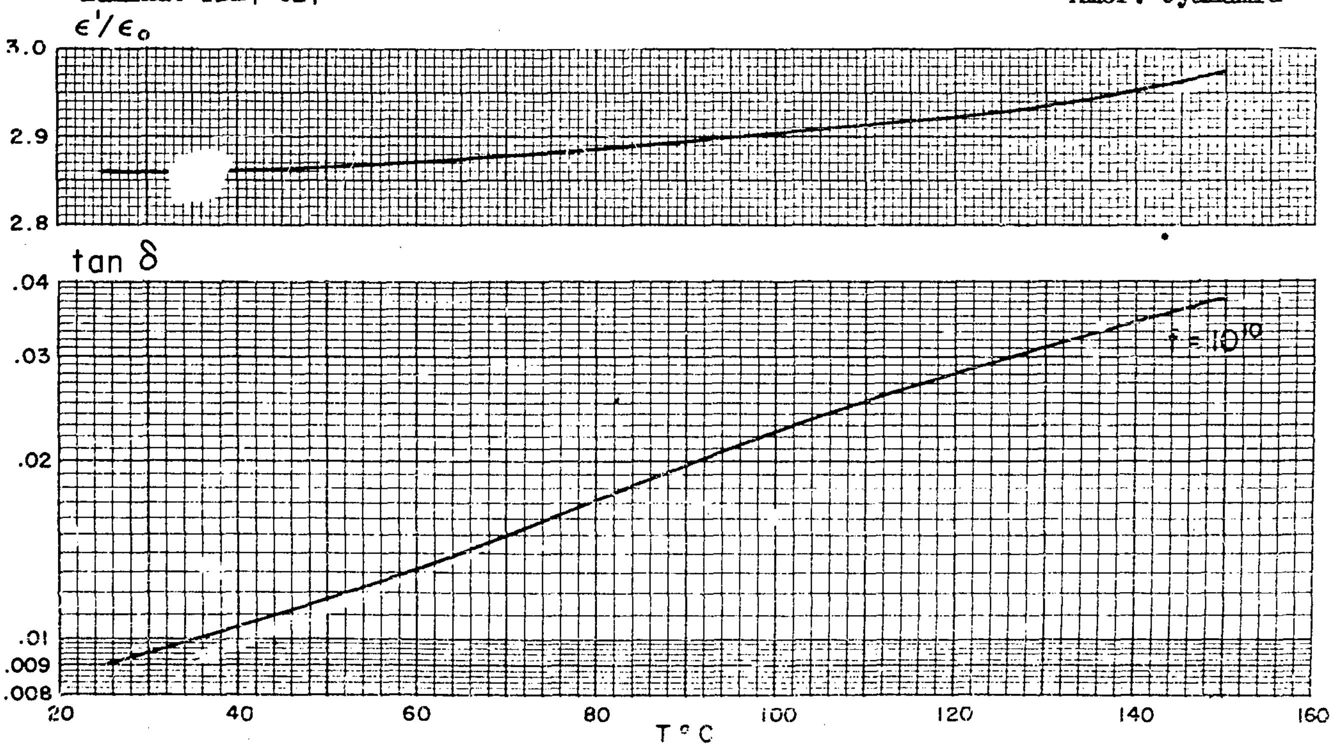


Polyesters

Laminac 4115 Amer. Cyanamid

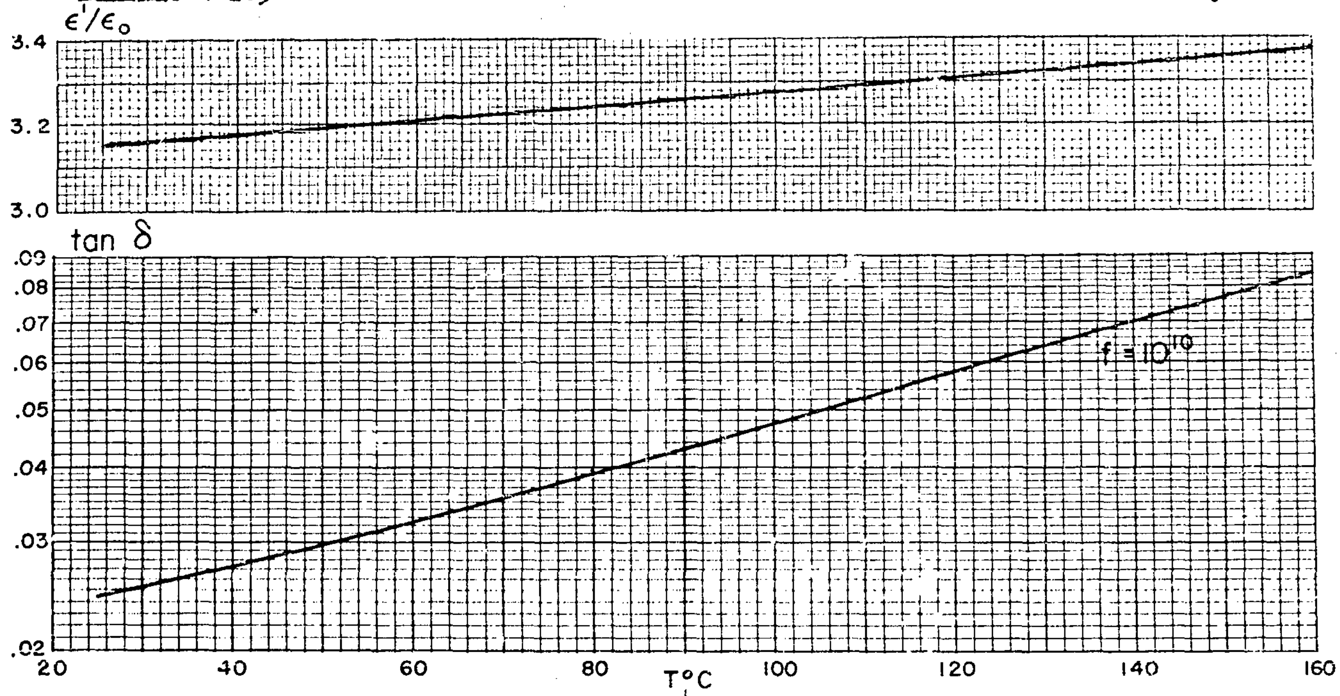


Laminac PDL7-627 Amer. Cyanamid

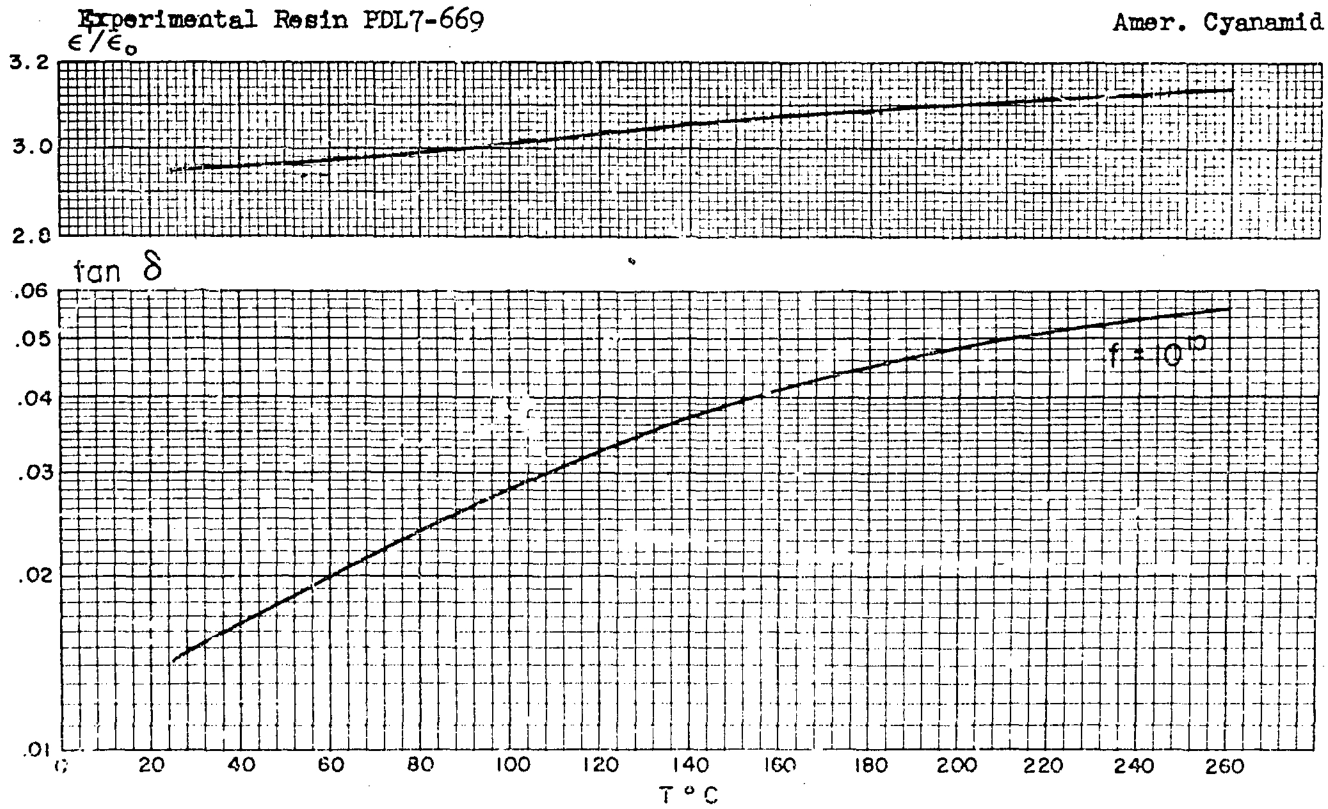


Polyesters (cont.)

Laminac 4-205 Amer. Cyanamid

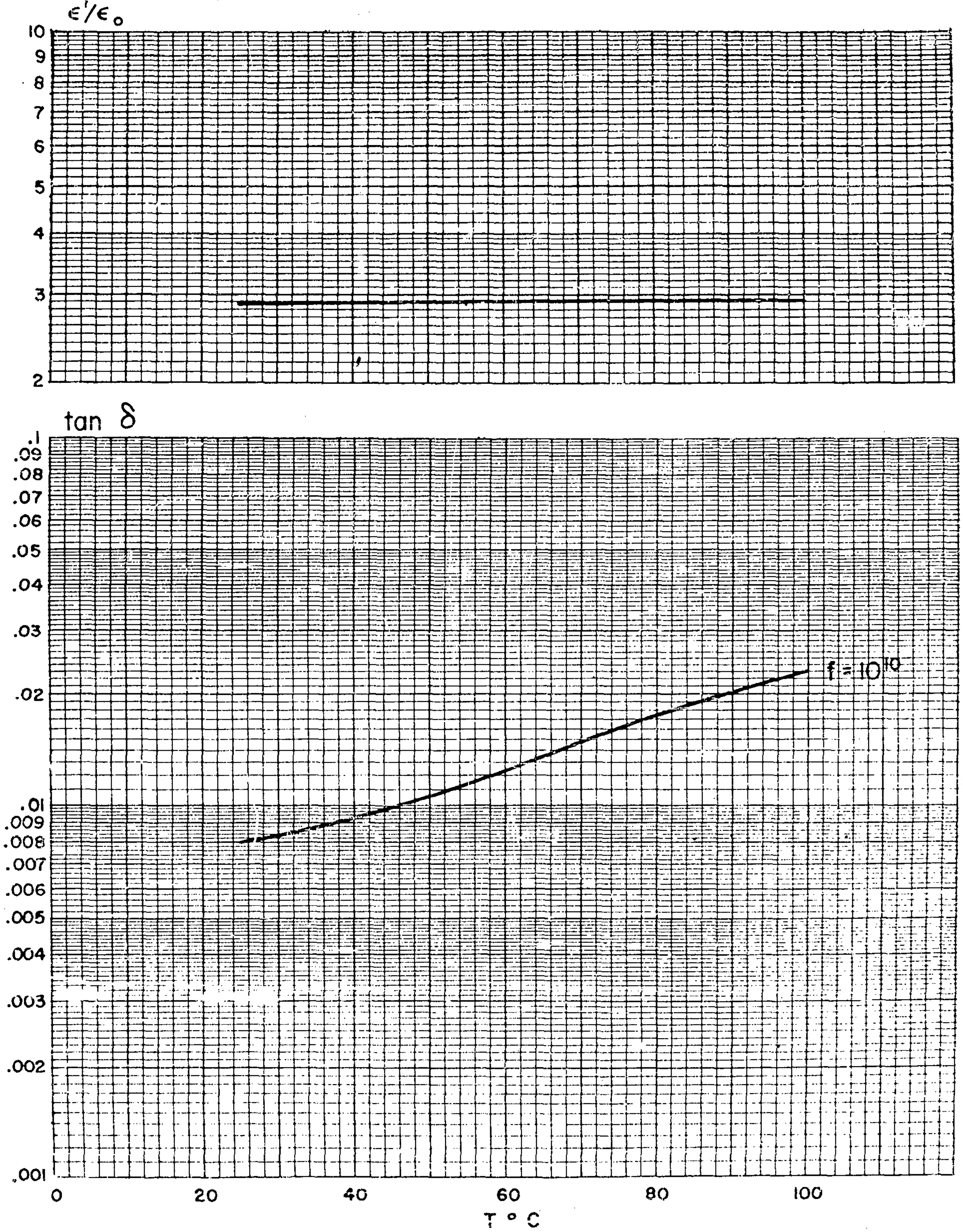


Experimental Resin PDL7-669 Amer. Cyanamid



Polyesters (cont.)

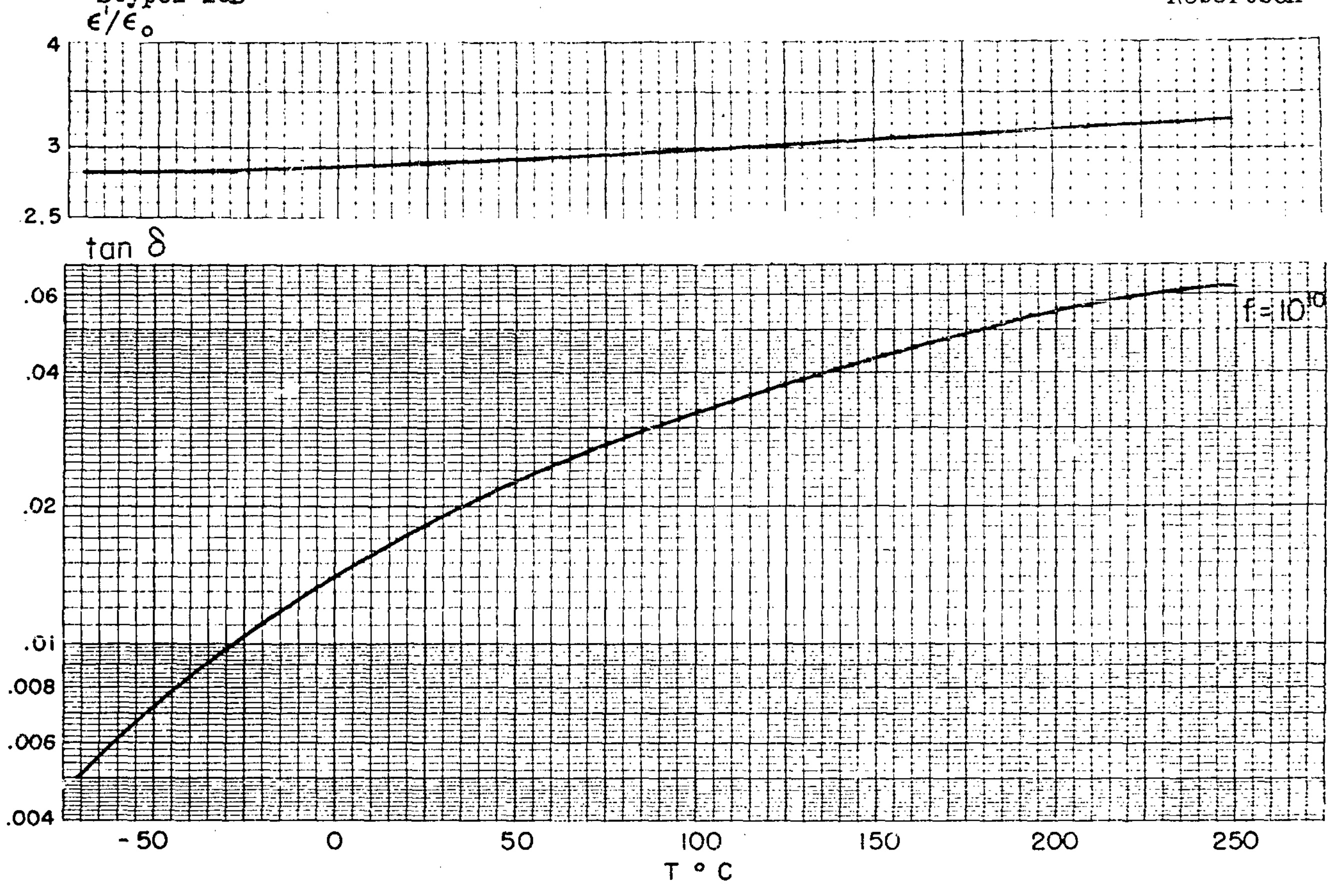
Paraplex P43 Rohm and Haas



Polyesters (cont.)

Stypol 16B

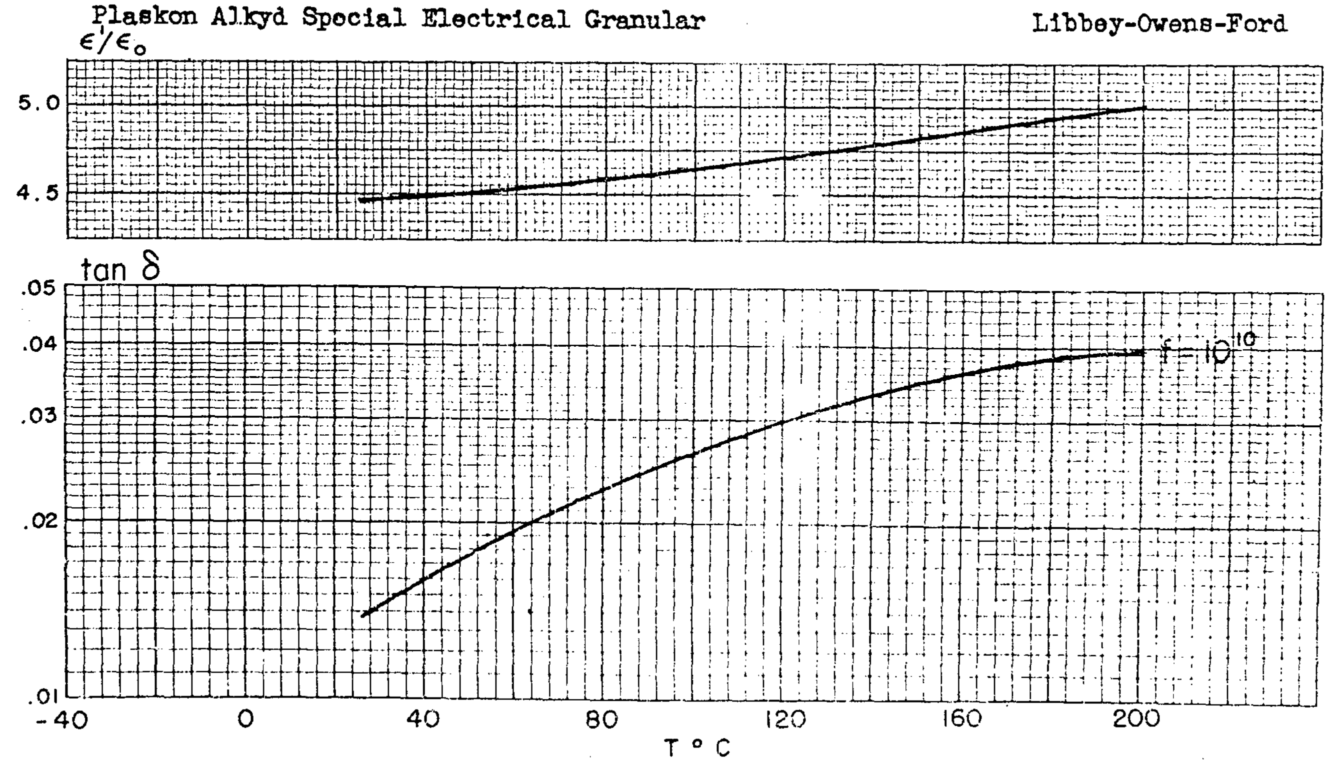
Robertson



Alkyd Resins

Plaskon Alkyd Special Electrical Granular

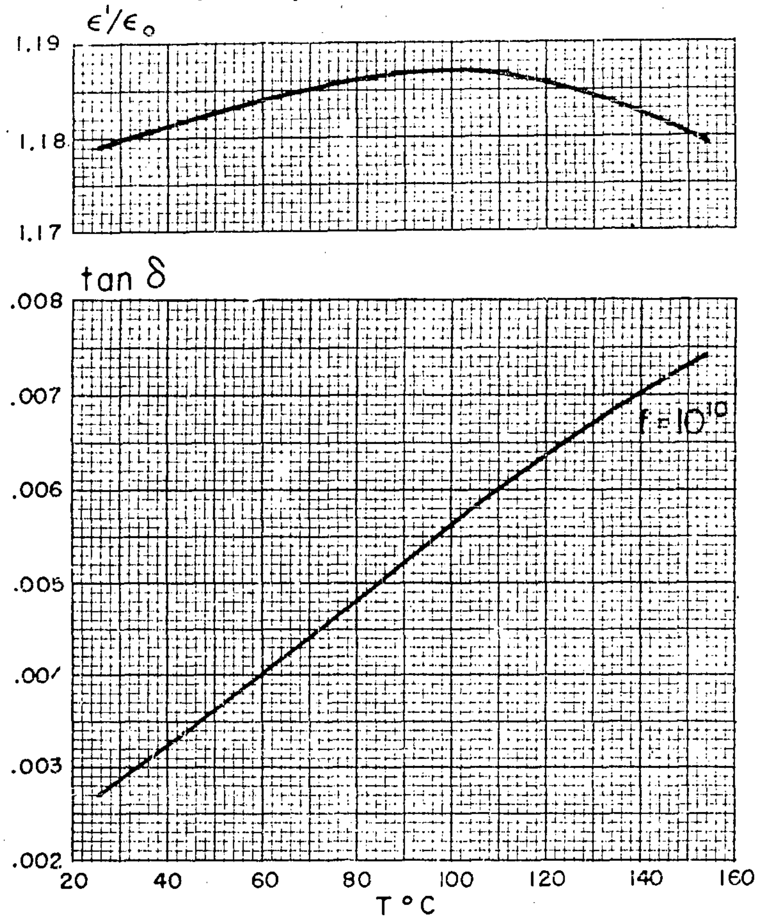
Libbey-Owens-Ford



Alkyd Resins (cont.)

Chlorinated alkyd diisocyanate, foamed

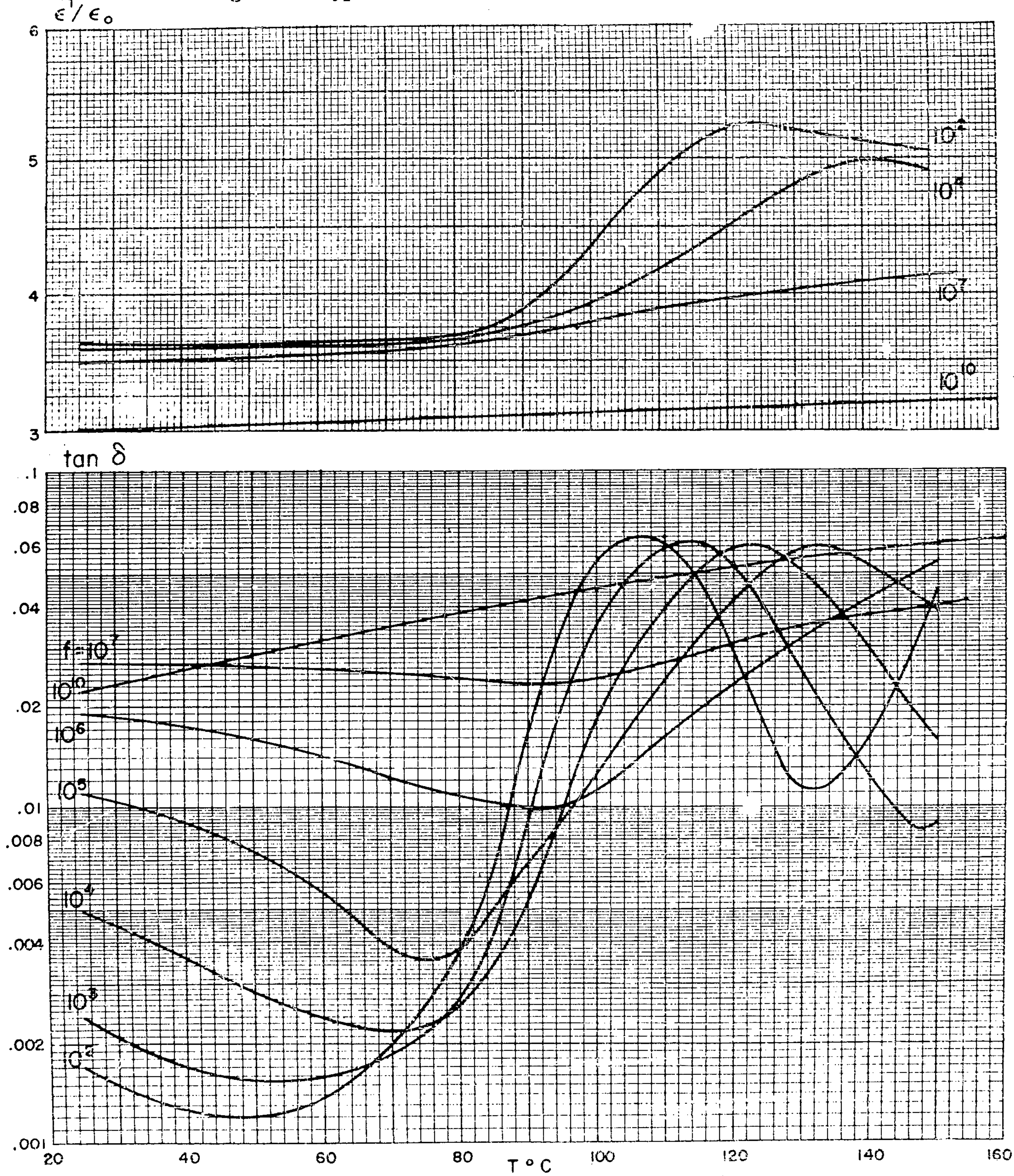
Cornell Aeronautical Labs.



Epoxy Resin

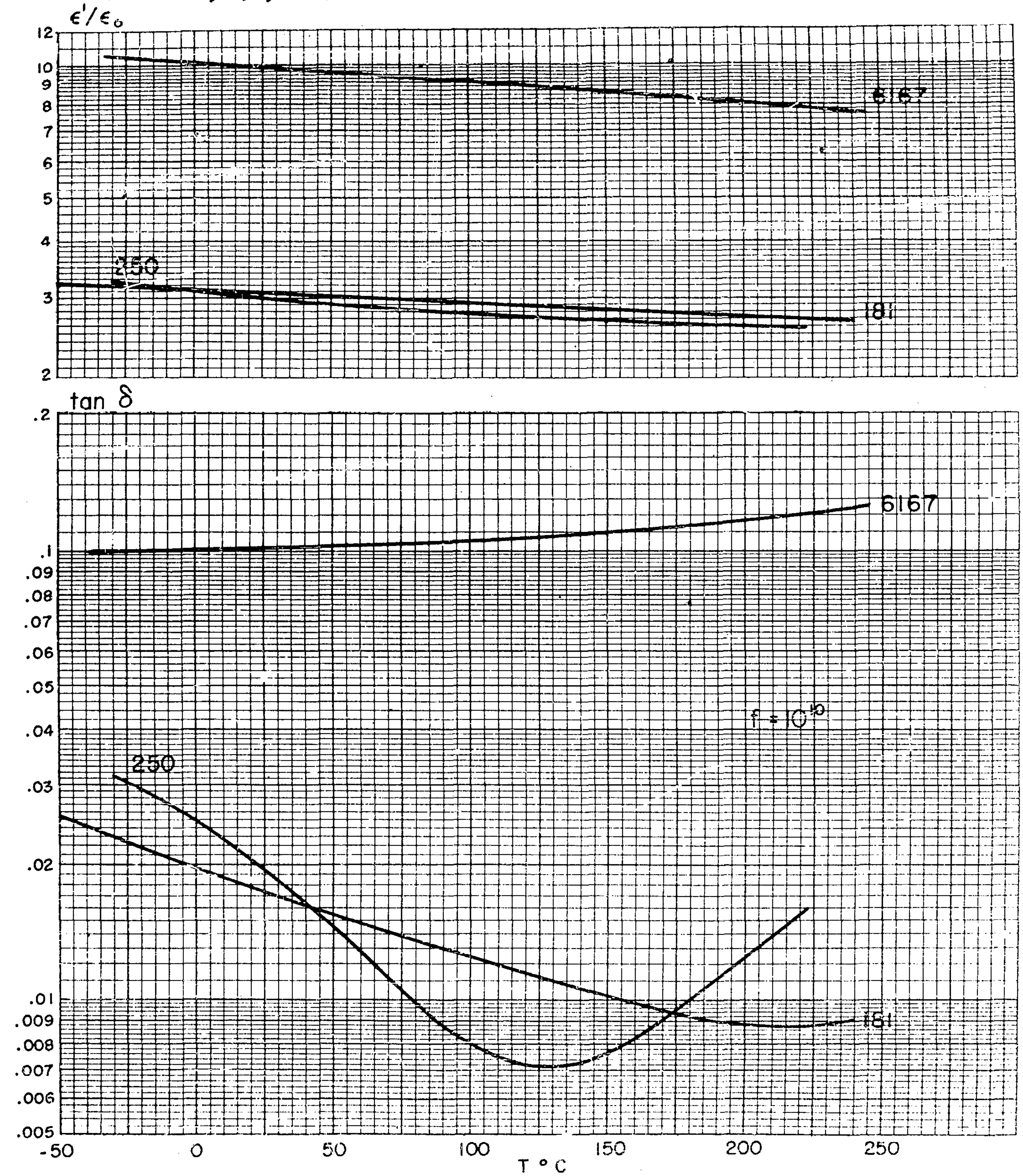
Araldite Casting Resin Type B

Ciba



Silicone Rubbers

Silastic 181, 250, 6167 — Dow Corning



Company Index

Company Index (cont.)

* Now The Borden Co., Chemical Div., 350 Madison Ave., New York 17, N. Y.

Company Index (cont.)

Company Index (cont.)

Company Index (cont.)

Materials Index

Materials Index (cont.)

Materials Index (cont.)

Materials Index (cont.)

Materials Index (cont.)

Materials Index (cont.)

Materials Index (cont.)

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UNCLASSIFIED